The Electrochemical Society • • •

105th Meeting

CHICAGO

May 2nd-6th, 1954

LOCAL COMMITTEE

Honorary Chairman
OLIVER W. STOREY

General Chairman
HOWARD T. FRANCIS
Armour Research Foundation

Advisory
R. SCOTT MODJESKA
Scientific Control Laboratories

Registration
ALBERT H. ROEBUCK
Argonne National Laboratory

Finance
SIMON P. GARY
Grunwald Plating Company

Entertainment
CLIFFORD A. HAMPEL
18223 Dixie Highway, Homewood, Ill.

Plant Trips
D. V. LOUZOS
Graham, Crowley & Associates

Arrangements
BEN FREEBERG
Vapor Car Heating Corporation

Ladies' Committee

MRS. OLIVER W. STOREY, *Honorary Chairman*
MISS MARGUERITE WALL, *Chairman*

MRS. WILLIAM H. COLNER
MRS. HOWARD T. FRANCIS
MRS. BEN FREEBERG
MRS. SIMON P. GARY
MRS. CLIFFORD A. HAMPEL
MRS. ERNEST L. KOEHLER
MRS. D. V. LOUZOS
MRS. R. SCOTT MODJESKA
MRS. ALBERT H. ROEBUCK

The Electrochemical Society

One Hundred and Fifth Meeting

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Sunday through Thursday
May 2, 3, 4, 5, and 6, 1954

CONDENSED TECHNICAL PROGRAM

Electric Insulation (Abstracts 1-21)

Monday morning, May 3—9:30 A.M.-12:00 M.
(Press Gallery, 18th floor)
Monday afternoon, May 3—2:10 P.M.-4:50 P.M.
(Press Gallery, 18th floor)
Tuesday morning, May 4—9:00 A.M.-12:30 P.M.
(Press Gallery, 18th floor)
Tuesday afternoon, May 4—2:00 P.M.-5:00 P.M.—
Round-Table Discussion
(Press Gallery, 18th floor)
Wednesday morning, May 5—9:00 A.M.-12:20 P.M.
(Press Gallery, 18th floor)
Wednesday afternoon, May 5—2:00 P.M.-3:20 P.M.
(Press Gallery, 18th floor)

Electronics—Instrumentation (Abstracts 22-27)

Tuesday afternoon, May 4—2:00 P.M.-5:15 P.M.
(Lincoln Room, 18th floor)

Electronics—Luminescence (Abstracts 28-44)

Monday morning, May 3—9:15 A.M.-12:25 P.M.
(Lincoln Room, 18th floor)
Monday afternoon, May 3—2:00 P.M.-5:00 P.M.
(Lincoln Room, 18th floor)
Tuesday morning, May 4—9:00 A.M.-12:30 P.M.—
Papers and Round-Table Discussion
(Lincoln Room, 18th floor)

Electronics—Phosphor Screen Application (Abstracts 45-50)

Wednesday morning, May 5—9:00 A.M.-12:00 M.
(Lincoln Room, 18th floor)
Wednesday afternoon, May 5—2:00 P.M.-5:00 P.M.—
Round-Table Discussion
(Lincoln Room, 18th floor)

Electronics—Rare Metals (Abstracts 51-69)

Thursday morning, May 6—9:00 A.M.-12:00 M.—
Joint Session with Electrothermic Division
(Lincoln Room, 18th floor)
Thursday afternoon, May 6—2:00 P.M.-5:20 P.M.—
Joint Session with Electrothermic Division
(Lincoln Room, 18th floor)

Electronics—Semiconductors (Abstracts 70-93)

Wednesday morning, May 5—9:00 A.M.-12:15 P.M.
(Century Room, 19th floor)
Wednesday afternoon, May 5—2:00 P.M.-5:00 P.M.
(Century Room, 19th floor)
Thursday morning, May 6—9:00 A.M.-12:00 M.
(Century Room, 19th floor)
Thursday afternoon, May 6—2:00 P.M.-5:00 P.M.
(Century Room, 19th floor)

Electrothermics (No abstracts)

Tuesday morning, May 4—9:15 A.M.-12:00 M.
(Illinois Room, Mezzanine)
Tuesday afternoon, May 4—2:00 P.M.-5:00 P.M.
(Illinois Room, Mezzanine)
Wednesday morning, May 5—9:15 A.M.-12:00 M.
(Chicago Room Mezzanine)
Wednesday afternoon, May 5—200 P.M.-5:00 P.M.
(Chicago Room, Mezzanine)
Thursday morning, May 6—9:00 A.M.-12:00 M.
Joint Session with Rare Metals
(Lincoln Room, 18th floor)
Thursday afternoon, May 6—2:00 P.M.-5:20 P.M.—
Joint Session with Rare Metals
(Lincoln Room, 18th floor)

Industrial Electrolytic (Abstracts 94-116)

Monday morning, May 3—9:30 A.M.-12:00 M.
(Century Room, 19th floor)
Monday afternoon, May 3—2:00 P.M.-5:00 P.M.—
Round-Table Discussion
(Century Room, 19th floor)
Tuesday morning, May 4—9:00 A.M.-12:00 M.
(Century Room, 19th floor)
Tuesday afternoon, May 4—2:00 P.M.-4:20 P.M.
(Century Room, 19th floor)

Theoretical Electrochemistry (Abstracts 117-146)

Monday morning, May 3—9:30 A.M.-12:00 M.
(Illinois Room, Mezzanine)
Monday afternoon, May 3—2:00 P.M.-5:00 P.M.
(Illinois Room, Mezzanine)
Tuesday morning, May 4—9:00 A.M.-12:00 M.
(Grand Ballroom, 19th floor)
Tuesday afternoon, May 4—2:00 P.M.-5:00 P.M.
(Grand Ballroom, 19th floor)
Wednesday morning, May 5—9:00 A.M.-12:00 M.
(Grand Ballroom, 19th floor)

GENERAL INFORMATION

Convention Headquarters will be at the LaSalle Hotel, LaSalle and Madison Streets, Chicago, Ill.

Rates per person for rooms will be: single room with bath, $6.50, 7.00, 7.50, 8.00, 8.50, 10.50; double room with bath, $9.00, 9.50, 10.00, 10.50, 11.00, 13.00; twin bedroom with bath, $12.50, 13.50, 14.50, 15.00; 2 single rooms with connecting bath, $12.50, 13.50; 2 rooms with connecting bath for 3, $14.50, 15.50, 17.50; 2 rooms with connecting bath for 4, $16.50, 17.50, 20.00; parlor, bedroom, and bath, $12.00, 13.00, 22.50, 24.00, 35.00; parlor and two bedrooms, $36.00, 37.50, 48.50.

Requests for room reservations should be made to: M. T. Mathewson, LaSalle Hotel, LaSalle & Madison Streets, Chicago 2, with mention of The Electrochemical Society.

The Secretary will have his office in the Society's headquarters rooms 1840 and 1842.

Technical Sessions will be held in rooms on the 18th and 19th floors and on the Mezzanine. Room names are supplemented by floor numbers in the program booklet for convenience in locating rooms quickly.

REGISTRATION

On Sunday, May 2, the registration desk will be located on the Mezzanine floor from 4:00 P.M. to 10:00 P.M. On Monday, Tuesday, Wednesday, and Thursday, May 3 to 6, the registration desk will be located on the 19th floor near the elevators. Monday, May 3, registration hours are from 8:00 A.M. to 5:00 P.M.; Tuesday, Wednesday, and Thursday from 9:00 A.M. to 5:00 P.M.

Registration fees are:

Members	$7.00	Students	$2.00
Ladies	$3.00	Nonmembers	$10.00

INFORMATION ABOUT CHICAGO

A display of information on points of interest, current plays, night clubs, restaurants, concerts, and other entertainment features in Chicago will be located near the registration desk. Through the courtesy of the "Chicago Welcome," booklets will be available describing up-to-the-minute attractions of all kinds.

An information desk will also be maintained to provide assistance in getting around Chicago. Fortunately, the city is set "square with the world," with Madison and State Streets as the "x" and "y" axes. In general, street numbers are

100 to the block, with eight blocks to the mile. The LaSalle Hotel is just three blocks west of the "origin." The "Loop," which circles the downtown area, is visible in all directions from any street corner.

ROUND-TABLE DISCUSSIONS AND SPECIAL SYMPOSIA

There will be four round-table discussions: Electric Insulation on "Casting and Potting Compounds" on Tuesday, May 4, at 2:00 P.M. in the Press Gallery (18th floor); Electronics—Luminescence on Tuesday, May 4, at 10:40 A.M. in the Lincoln Room (18th floor); Electronics—Phosphor Screen Application on Wednesday, May 5, at 2:00 P.M. in the Lincoln Room (18th floor); and Industrial Electrolytic on Monday, May 3, at 2:00 P.M. in the Century Room (19th floor).

Electronics—Rare Metals and Electrothermic Divisions are holding special joint symposia on Refractory Compounds and Refractory Metals. The Electrothermic Division has scheduled special symposia on the Electric Arc Furnace, and the Theoretical Electrochemistry Division is holding a special symposium on Special Methods in Electrochemistry.

LUNCHEONS AND DINNERS

Monday Evening Buffet Supper and Entertainment

An informal cocktail hour and buffet supper has been arranged for Monday evening, May 3. The buffet will be complete with choice beef, turkeys, and hams. Following supper, entertainment of the sort you will enjoy has been arranged. Plan to attend this affair if you enjoy good food and a good show; it will be held in the Grand Boolroom (19th floor) at 6:30 P.M.

Tuesday Luncheon and Annual Business Meeting

The general Society Luncheon will be served in the Grand Ballroom (19th floor) on Tuesday, May 4, following which the annual business meeting will be held. Casper W. Ooms, former U. S. Commissioner of Patents, will speak on "The Patent Problem in Atomic Energy Legislation."

Tuesday Evening Reception and Banquet

A reception for President and Mrs. R. J. McKay will be held on Tuesday evening, May 4, in the Grand Ballroom (19th floor). Following cocktails at 6:30 P.M. and the LaSalle's best dinner, President McKay will deliver the presiden-

tial address. Music has been arranged for dancing for the rest of the evening.

Wednesday Evening Section Q Meeting

If you enjoy a little poker or bridge, or just a congenial evening of conversation with friends you see only once in a while, the Press Gallery (18th floor) and Card Room will be set up for your disposal all evening. Always a popular ECS feature, this will be a place to "come back to" if you go out to dinner or a show on Wednesday.

PLANT TRIPS

In view of the large attendance anticipated at the convention, it will probably be necessary to limit the number participating in each trip. You are urged, therefore, to make your decisions on trips desired **by Monday evening.** In this way adequate facilities can be provided and last-minute disappointments avoided.

Tuesday afternoon—An inspection of the Western Electric Company's cable manufacturing operations has been arranged.

Wednesday afternoon — A complimentary luncheon and tour through the shops and laboratories of E. H. Sargent and Company is scheduled. The many electrical and electronic instruments manufactured in this ultramodern plant will be well worth inspecting.

Thursday afternoon—A tour through certain sections of the Museum of Science and Industry is arranged to suit the interests of the Divisions holding sessions. The electronics and electrical exhibits are beautifully designed to illustrate basic principles as well as practical applications.

Thursday—A visit to one of the Zenith Radio Corporation plants is planned for Thursday. Final information on plant and time of trip will be available at the registration desk.

LADIES' PROGRAM

Ladies' Headquarters will be in Room 1809 throughout the convention. An effort has been made to schedule activities of interest, yet to permit flexibility and to provide some free time for individual choice.

Monday morning—A get-acquainted meeting will be held at which coffee (or tea!) and rolls will be served and preferences for later activities can be discussed. (Complimentary)

Monday afternoon—A trip (or group of trips) to points of interest in Chicago is planned, guided by members of the Ladies' Committee. (Transportation complimentary)

Monday evening—The ladies will certainly want to attend the Buffet Supper and Entertainment in the Grand Ballroom (19th floor).($6.50)

Tuesday Luncheon—The ladies are invited to attend the Society Luncheon, to be held in the Grand Ballroom (19th floor). ($3.60)

Tuesday afternoon—This afternoon is reserved for shopping or any other activity of individual preference.

Tuesday evening—This is a "must" for the ladies—the reception for President and Mrs. McKay, cocktails, an excellent dinner, and dancing, Grand Ballroom (19th floor). ($13.00 per couple)

Wednesday luncheon and afternoon—A luncheon and fashion show, followed by a matinee theater party is planned. (Details at registration desk)

Wednesday evening—Please don't hesitate to join the Section Q meeting at any time on Wednesday evening—ladies are welcome! Press Gallery (18th floor).

Thursday afternoon — A visit to Chicago's famed Museum of Science and Industry, jointly with a plant trip there, is planned for Thursday. A special tour of exhibits which are of feminine interest is scheduled. (Complimentary)

LUNCHEONS AND BUSINESS MEETINGS OF DIVISIONS

Electric Insulation Division will hold a luncheon and business meeting on Monday, May 3, at 12:30 P.M. in the Illinois Room (Mezzanine).

Electronics Division will hold a luncheon and business meeting on Wednesday, May 5, at 12:30 P.M. in Parlor D (Mezzanine).

Electrothermic Division will hold a luncheon and business meeting on Thursday, May 6, at 12:30 P.M. in the Chicago Room (Mezzanine).

Industrial Electrolytic Division will hold a luncheon and business meeting on Monday, May 3, at 12:30 P.M. in the Chicago Room (Mezzanine).

BOARD AND COMMITTEE MEETINGS

Sunday, May 2, 10:00 A.M.—Meeting of the Ways and Means Committee in Parlor D (Mezzanine).

Sunday, May 2, 2:00 P.M.—Meeting of the Board of Directors in Parlor D (Mezzanine).

Monday, May 3, 5:00 P.M.—Meeting of the Local Section Advisory Committee in Room 1860.

Monday, May 3, 5:00 P.M.—Meeting of the Membership Committee in Room 209.

Tuesday, May 4, 5:00 P.M.—Meeting of the Editorial Staff in Room 1860.

Tuesday, May 4, 5:00 P.M.—Meeting of the Sustaining Membership Committee in Room 209.

COST OF FUNCTIONS

(other than registration)

Division Luncheons	$ 3.60
Monday Cocktails, Buffet Supper, and Entertainment	$ 6.50
Tuesday Society Luncheon	$ 3.60
Tuesday Reception, Cocktails, Dinner, and Dancing (single)	$ 7.50
(couple)	$13.00

JOURNALS

Copies of the January, February, March, and April issues of the Journal of The Electrochemical Society containing some of the papers presented will be available at the registration desk. The price of a single copy of the Journal is $1.25 to members and $1.50 to nonmembers.

EXTENDED ABSTRACTS

The Electronics Division again is making available an extended abstract booklet containing 1000-word abstracts of most of the papers presented at the Division's Chicago symposia. Copies of the booklet will be on sale at the registration desk for $2.00.

DISCUSSION

There will be no recordings made of oral discussions. Those contributing to the discussion of a paper and desiring their remarks published will be supplied with a printed form on which any discussion may be written. These forms should be given to the Secretary-Treasurer of the Division at the end of the session. The discussion will then be referred to the authors for reply. Written discussion will be accepted up to two months following publication of any article in the JOURNAL.

A discussion section is published semiannually in the JOURNAL.

MEETING ROOM SCHEDULES

Meetings	Monday A.M.	Monday P.M.	Tuesday A.M.	Tuesday P.M.	Wednesday A.M.	Wednesday P.M.	Thursday A.M.	Thursday P.M.
Electric Insulation	A	A	A	A	A	A		
Electronics—								
Instrumentation				C				
Luminescence	C	C	C					
Phosphor Screen Application					C	C		
Rare Metals							C*	C*
Semiconductor					B	B	B	B
Electrothermics			D	D	F	F	C*	C*
Industrial Electrolytic	B	B	B	B				
Theoretical Electrochemistry	D	D	E	E	E			

A—Press Gallery, 18th floor.
B—Century Room, 19th floor.
C—Lincoln Room, 18th floor.
D—Illinois Room, Mezzanine.
E—Grand Ballroom, 19th floor.
F—Chicago Room, Mezzanine.
*—Joint session.

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Technical Program

Monday, May 3, 1954

9:00 A.M.—Formal Opening of the 105th Convention, with Introduction by General Chairman Howard T. Francis and response by President R. J. McKay. (Century Room, 19th floor)

ELECTRIC INSULATION

Monday, May 3, 1954

Electrophysics

with C. F. Miller presiding

(PRESS GALLERY, 18th floor)

9:30 A.M.—"Experiments Concerning the Infrared Goniometric Reflectance Characteristics of Metallic Surfaces" by John T. Agnew and Richmond B. McQuistan, Purdue University, Lafayette, Ind., and Leon L. Deer, U. S. Naval Ordnance, Indianapolis, Ind. (Abstract No. 1)

10:10 A.M. — "Paramagnetic Resonance with Some Applications to Problems in Chemistry

and Physics" by Clyde A. Hutchison, Jr., Institute for Nuclear Studies, University of Chicago, Chicago, Ill. (Abstract No. 2)

10:50 A.M.—"Reduction of Oxidation-Ions in Hydrocarbons" by Andrew Gemant, Engineering Laboratory and Research Department, The Detroit Edison Company, Detroit, Mich. (Abstract No. 3)

11:20 A.M.—"Electrostatic Properties of Charged Dielectric Sheets" by H. T. McLean, General Engineering Laboratory, General Electric Company, Schenectady, N. Y. (Abstract No. 4)

12:30 P.M.—Electric Insulation Division Luncheon and Business Meeting in the Illinois Room (Mezzanine). Speaker, Dr. John Rettaliata, President, Illinois Institute of Technology, Chicago, Ill.

Electric Insulation (cont'd)

Dielectric Liquids

with C. F. Miller presiding

(PRESS GALLERY, 18th floor)

2:10 P.M. — "Transformer Oil: Properties of Naphthenic and Aromatic Fractions" by R. Nichols Hazelwood, Raymond M. Frey, and Joanne B. Broecker, Line Material Company (A McGraw Electric Company Division), South Milwaukee, Wis. (Abstract No. 5)

2:50 P.M.—"Dielectric Dispersion of Mixtures of Chlorinated Biphenyls with Trichlorobenzene and with Diphenyl Ether" by Robert J. Good, Department of Applied Science, University of Cincinnati, Cincinnati, Ohio. (Abstract No. 6)

3:30 P.M.—"Stabilization of Dielectrics" by D. A. McLean, Bell Telephone Laboratories, Inc., Murray Hill, N. J. (Abstract No. 7)

4:10 P.M.—"Electrical Properties of Commercial Liquid Dielectrics" by Thomas D. Callinan, Naval Research Laboratory, Washington, D. C. (Abstract No. 8)

Tuesday, May 4, 1954

Electric Insulation (cont'd)

with R. A. Ruscetta presiding

(PRESS GALLERY, 18th floor)

9:00 A.M.—"Recent Developments in Integrated Mica" by M. D. Heyman, Integrated Mica Cor-

poration, Woodmere, N. Y. (Abstract No. 9)

9:40 A.M.—"Electrical Properties of 'Adraldite' Ethoxyline Resins" by M. Wismer and J. Durra, Ciba Corporation, New York, N. Y. (Abstract No. 10)

10:20 A.M.—"Du Pont 'Mylar' Polyester Film, A New and Versatile Electrical Insulation" by J. A. Ruby, Sales Development and Technical Service, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del. (Abstract No. 11)

11:00 A.M.—" 'Bakelite' Cellular Polyethylene" by W. T. Higgins, Bakelite Company, Division of Union Carbide & Carbon Corporation, Bound Brook, N. J. (Abstract No. 12)

11:40 A.M.—"Applications of Isocyanates in the Electrical Industry" by J. H. Saunders and Edgar E. Hardy, Monsanto Chemical Company, Anniston, Ala. (Abstract No. 13)

12:30 P.M.—Society Luncheon and Annual Business Meeting in the Grand Ballroom (19th floor).

Electric Insulation (cont'd)

Round-Table Discussion

Casting and Potting Compounds

with L. L. Deer presiding

(PRESS GALLERY, 18th floor)

2:00 P.M.—The panel will include representatives from both the material manufacturers and users and will discuss the problems that confront the industry.

"New Casting Resins for Miniaturization" by P. Rector, National Engineering Products Company, Washington, D. C. (Abstract No. 14)

Wednesday, May 5, 1954

Electric Insulation (cont'd)

with D. A. Lupfer presiding

(PRESS GALLERY, 18th floor)

9:00 A.M.—"Aging Characteristics of Class 'H' Insulation" by Edwin Lotz, Coating Division, Irvington Varnish and Insulator Company, Irvington, N. J. (Abstract No. 15)

9:40 A.M.—"More Advantageous Use of Layer Insulations from Thickness-Dielectric Strength

Relationships" by Paul Doigan, Materials and Process Laboratory, General Electric Company, Pittsfield, Mass. (Abstract No. 16)

10:20 A.M. — "Survey of Arc-Resistance and Tracking Characteristics of Plastics" by W. C. Wikstrand and C. F. Spiers, Research Laboratory, American Cyanamid Company, Stamford, Conn. (Abstract No. 17)

11:00 A.M.—"Effect of Moisture, Temperature, and Frequency on the Electrical Properties of Insulating Materials" by L. J. Frisco, Dielectrics Laboratory, The Johns Hopkins University, Institute for Cooperative Research, Baltimore, Md. (Abstract No. 18)

11:40 A.M.—"Breakdown Phenomena as Related to Other Dielectric Properties" by J. J. Chapman, Dielectrics Laboratory, The Johns Hopkins University, Institute for Cooperative Research, Baltimore, Md. (Abstract No. 19)

Electric Insulation (cont'd)

with D. A. Lupfer presiding

(PRESS GALLERY, 18th floor)

2:00 P.M.—"Review of Metal-Ceramic Seals" by Hayne Palmour, III, American Lava Corporation, Chattanooga, Tenn. (Abstract No. 20)

2:40 P.M.—"Review of High Temperature Insulations Including Varnished Cloths, Mica Paper, and Other Sheet Materials" by A. J. Sherburne and R. W. Staley, General Electric Company, Coshocton, Ohio. (Abstract No. 21)

ELECTRONICS—INSTRUMENTATION

Tuesday, May 4, 1954

with A. E. Martin presiding

(LINCOLN ROOM, 18th floor)

2:00 P.M.—Introductory remarks by A. E. Martin.

2:05 P.M.—"Stabilized Power Supplies for Instrument Applications" by W. G. Amey, F. H. Krantz, W. R. Clark, and A. J. Williams, Jr., Research Department, Leeds & Northrup Company, Philadelphia, Pa. (Abstract No. 22)

2:35 P.M.—"High-Frequency Instrumentation" by J. C. Clayton, J. Fred Hazel, Wallace M. McNabb, and G. L. Schnable, Department of Chemistry, University of Pennsylvania, Philadelphia, Pa. (Abstract No. 23)

3:05 P.M.—"Measurement of Fluorescence Decay Times" by S. H. Liebson, Electricity Division, Naval Research Laboratory, Washington, D. C. (Abstract No. 25)

3:35 P.M.—Intermission.

3:45 P.M.—"Measurement of Color Uniformity of Black and White Kinescope Screens" by Austin E. Hardy, Tube Department, Radio Corporation of America, Lancaster, Pa. (Abstract No. 26)

4:15 P.M.—"Photoelectric Tristimulus Methods of Phosphor Color Measurement" by Richard S. Hunter, Hunter Associates Laboratory, Falls Church, Va. (Abstract No. 27)

ELECTRONICS—LUMINESCENCE

Monday, May 3, 1954

with C. W. Jerome presiding

(LINCOLN ROOM, 18th floor)

9:15 A.M.—Keynote address — "Luminescence Facts and Foibles" by Humboldt W. Leverenz, RCA Laboratories, Princeton, N. J. (Abstract No. 28)

9:45 A.M.—"Heat Treatment of Zinc Sulfide Single Crystals" by Alfred Kremheller, Physics Laboratories, Sylvania Electric Products Inc., Bayside, N. Y. (Abstract No. 29)

10:10 A.M.—"Adsorption of Precipitated Zinc Sulfide for Chloride and Sulfate Ions" by Dominic T. Palumbo, Physics Laboratories, Sylvania Electric Products Inc., Bayside, N. Y., and Albert K. Levine, Department of Chemistry, Brooklyn College, Brooklyn, N. Y., and Sylvania Electric Products Inc., Bayside, N. Y. (Abstract No. 30)

10:35 A.M.—"Examination of the Role of Fluxes in Zinc Sulfide Phosphor Preparation" by Paul Goldberg, Physics Laboratories, Sylvania Electric Products Inc., Bayside, N. Y., and Albert K. Levine, Department of Chemistry, Brooklyn College, Brooklyn, N. Y., and Sylvania Electric Products Inc., Bayside, N. Y. (Abstract No. 31)

11:00 A.M.—"Surface States of Cadmium Sulfide" by S. H. Liebson, Electricity Division, Electromagnetics Branch, Naval Research Laboratory, Washington, D. C. (Abstract No. 32)

11:30 A.M.—"Luminescence of Zinc Sulfide Phos-

phors" by Laurence Burns, Sylvania Electric Products Inc., Salem, Mass. (Abstract No. 33)

12:00 M.—"A Model for Luminescence and Conductivity in Sulfides" by Clifford C. Klick, Chemistry Branch, Metallurgy Division, and John Lambe, Electromagnetics Branch, Electricity Division, Naval Research Laboratory, Washington, D. C. (Abstract No. 34)

Electronics—Luminescence (cont'd)

with Robert J. Ginther presiding

(LINCOLN ROOM, 18th floor)

2:00 P.M.—"Trapping in ZnS:Cu:Co" by B. Goldstein and J. J. Dropkin, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. (Abstract No. 35)

2:30 P.M.—"Temperature Dependence of the Fluorescence of ZnS Phosphors" by Spotswood D. Bowers, Jr., United States Radium Corporation, Bloomsburg, Pa. (Abstract No. 36)

3:00 P.M.—"Some Electroluminescent Effects and Their Interpretation" by Frank Matossi and Sol Nudelman, U. S. Naval Ordnance Laboratory, White Oak, Md. (Abstract No. 37)

3:30 P.M.—"Electroluminescence in ZnS Single Crystals" by W. R. Watson and A. T. Halpin, Physics Laboratories, Sylvania Electric Products Inc., Bayside, N. Y., and J. J. Dropkin, Polytechnic Institute of Brooklyn, Brooklyn, N. Y., and Sylvania Electric Products Inc., Bayside, N. Y. (Abstract No. 38)

4:00 P.M.—"Increase of Luminescence Sensitivity to X-Rays of Some Mixtures of Zinc Sulfide and Cadmium Sulfide under the Action of Alternating Electric Fields" by G. Destriau, Consultant, Westinghouse Electric Corporation, Bloomfield, N. J., and Faculté des Sciences de Paris, France. (Abstract No. 39)

4:30 P.M.—"Electroluminescent Lamps Using Glass Dielectrics" by Richard M. Rulon, Sylvania Electric Products Inc., Salem, Mass. (Abstract No. 40)

Tuesday, May 4, 1954

Electronics—Luminescence (cont'd)

with J. J. Dropkin presiding

(LINCOLN ROOM, 18th floor)

9:00 A.M.—"Modified Calcium Pyrophosphate

Phosphors" by D. E. Kinney, Chemical Products Works, General Electric Company, Cleveland, Ohio. (Abstract No. 41)

9:25 A.M.—"Emission Spectrum of CaF_2 : (Ce + Mn)" by Robert J. Ginther, Chemistry Branch, Metallurgy Division, Naval Research Laboratory, Washington, D. C. (Abstract No. 42)

9:50 A.M.—"Antimony Oxide Phosphor with Red Emission" by Yoshihide Kotera and Tadao Sekine, Fifth Division, Government Chemical Industrial Research Institute, Tokyo, Japan. (Abstract No. 43)

10:15 A.M. — "Lanthanum Oxychloride Phosphors" by Frank E. Swindells, Photo Products Department, E. I. du Pont de Nemours & Company, Inc., Parlin, N. J. (Abstract No. 44)

10:40 A.M.-12:30 P.M.—Round - Table Discussion.

12:30 P.M.—Society Luncheon and Annual Business Meeting in the Grand Ballroom (19th floor).

ELECTRONICS—PHOSPHOR SCREEN APPLICATION

Wednesday, May 5, 1954

with A. Steadman presiding

(LINCOLN ROOM, 18th floor)

9:00 A.M.—Introductory remarks by A. Steadman.

9:05 A.M.—"Some Factors Affecting Screening and Screen Strength in Cathode Ray Tubes" by J. Fred Hazel, Department of Chemistry, University of Pennsylvania, Philadelphia, Pa., and William Stericker, Philadelphia Quartz Company, Philadelphia, Pa. (Abstract No. 45)

9:30 A.M.—"Interaction of Barium Salts with Potassium Silicate Solutions" by J. Fred Hazel, Wallace M. McNabb, and C. A. Crutchfield, Jr., Department of Chemistry, University of Pennsylvania, Philadelphia, Pa. (Abstract No. 46)

10:00 A.M.—"A Study of Barium and Silicate Concentrations in Phosphor Screen Application" by Russell B. Snyder and Leonard Maisel, Allen B. Du Mont Laboratories, Inc., Clifton, N. J. (Abstract No. 47)

10:35 A.M.—**"Secondary Electron Emission of All-Sulfide Phosphor Screens"** by G. P. Kirkpatrick, Radio Corporation of America, Lancaster, Pa. (Abstract No. 48)

11:00 A.M.—**"Use of Screen Potential Measurement Equipment in Evaluating Cathode Ray Tube Screens"** by T. V. Rychlewski and L. W. Evans, Sylvania Electric Products Inc., Seneca Falls, N. Y. (Abstract No. 49)

11:25 A.M.—**"Filming and Aluminizing Processes for Cathode Ray Tubes"** by Channing Dichter and Vanja Srepel, General Electric Company, Syracuse, N. Y. (Abstract No. 50)

12:30 P.M.—Electronics Division Luncheon and Business Meeting in Parlor D (Mezzanine).

Round Table

Electronics—Phosphor Screen Application (cont'd)

with Marvin Rathfelder presiding

(LINCOLN ROOM, 18th floor)

2:00-5:00 P.M.—Round-table discussion. Speakers will include C. Dichter, A. Hardy, J. Fred Hazel, E. C. Larsen, M. Sadowsky, A. Steadman, and L. T. Weagle.

Joint Session

ELECTRONICS-RARE METALS—ELECTROTHERMICS

Thursday, May 6, 1954

Refractory Compounds

with J. H. Westbrook presiding

(LINCOLN ROOM, 18th floor)

9:00 A.M.—**"Metallic Composites"** by J. Wulff, Department of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 51)

9:20 A.M.—**"Preparation of Refractory Compounds Having Controlled Microstructure"** by R. Atkinson, R. Read, and A. J. Shaler, Department of Mineral Technology, Pennsylvania State College, State College, Pa. (Abstract No. 52)

9:40 A.M.—"Temperature Dependence of Hardness of the Equi-Atomic Iron Group Aluminides" by J. H. Westbrook, Research Laboratory, General Electric Company, Schenectady, N. Y. (Abstract No. 53)

10:00 A.M.—"Discilicides—New Refractory Alloys" by Roger A. Long, Aircraft Components Division, Ferrotherm, Cleveland, Ohio. (Abstract No. 54)

10:20 A.M.—"Titanium Silicide as a Refractory Coating" by Stanley Kluz, Ralph Wehrmann, and L. F. Yntema, Fansteel Metallurgical Corporation, North Chicago, Ill. (Abstract No. 55)

10:40 A.M.—"Physical Properties of Transition Metal Diborides" by Frank W. Glaser and David Moskowitz, American Electro Metal Corporation, Yonkers, N. Y., and Benjamin Post, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. (Abstract No. 56)

11:00 A.M.—"Preparation and Crystal Structures of Some High Melting Thorium-Germanium Compounds" by A. W. Searcy and A. G. Tharp, Purdue University, Lafayette, Ind. (Abstract No. 57)

11:20 A.M.—"Resistance Sintering under Pressure of Refractory Materials" by F. V. Lenel, Department of Metallurgical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. (Abstract No. 58)

11:40 A.M.—"Electrothermal Heating of Solutions" by Kenneth A. Kobe, University of Texas, Austin, Texas, and Carl J. Carlson, Standard Oil Company of California, Avenal, Calif. (Abstract No. 59)

Joint Session (cont'd)

Electronics-Rare Metals—Electrothermics (cont'd)

Refractory Metals

with A. U. Seybolt presiding

(LINCOLN ROOM, 18th floor)

2:00 P.M.—"Determination of the Gas Content of Metals of High Purity by Vacuum Fusion" by M. W. Mallett, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 60)

2:20 P.M.—"An Investigation of the Hydrogen Chloride Volatilization Method for the Analysis of Oxygen in Zirconium" by Russell H. Atkinson, Lamp Division, Westinghouse Electric Corporation, Bloomfield, N. J. (Abstract No. 61)

2:40 P.M.—"Recent Investigations in the Control and Operation of Zirconium Production Furnaces" by F. E. Block and A. D. Abraham, Bureau of Mines, U. S. Department of the Interior, Albany, Oreg. (Abstract No. 62)

3:00 P.M.—"Crystal Structure and Thermodynamic Studies on Zirconium-Hydrogen Alloys" by Earl A. Gulbransen and Kenneth F. Andrew, Westinghouse Research Laboratories, East Pittsburgh, Pa. (Abstract No. 63)

3:20 P.M.—"Diffusion of Hydrogen in High Purity Zirconium" by Earl A. Gulbransen and Kenneth F. Andrew, Westinghouse Research Laboratories, East Pittsburgh, Pa. (Abstract No. 64)

3:40 P.M.—"Room-Temperature Ductile Chromium" by H. Johansen and G. Asai, Bureau of Mines, U. S. Department of the Interior, Albany, Oreg. (Abstract No. 65)

4:00 P.M.—"A Metallurgical Evaluation of Iodide Chromium" by D. J. Maykuth, W. D. Klopp, R. I. Jaffee, and H. B. Goodwin, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 66)

4:20 P.M.—"Preparation of High Purity Thorium by the Iodide Process" by N. D. Veigel, E. M. Sherwood, and I. E. Campbell, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 67)

4:40 P.M.—"High Temperature Crystal Structure of Thorium" by P. Chiotti, Iowa State College, Ames, Iowa. (Abstract No. 68)

5:00 P.M.—"Vapor Pressure of Rhenium" by D. M. Rosenbaum, E. M. Sherwood, J. M. Blocher, Jr., and I. E. Campbell, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 69)

ELECTRONICS—SEMICONDUCTORS

Wednesday, May 5, 1954

Intermetallic Compounds

with A. E. Middleton presiding

(CENTURY ROOM, 19th floor)

9:00 A.M.—Introductory remarks by A. E. Middleton.

9:05 A.M.—Keynote Address—**"Semiconductor Research and Development in Germany"** by Herbert F. Matare, Intermetal Corporation, New York, N. Y. (Abstract No. 70)

9:45 A.M.—"Electrical Properties of Some Group III-Group V Compounds" by H. J. Hrostowski and M. Tanenbaum, Bell Telephone Laboratories, Inc., Murray Hill, N. J. (Abstract No. 71)

10:15 A.M.—"Band Separation of a Number of Semiconducting Compounds from Optical Data" by Richard W. Koch, James F. Miller, and Harvey L. Goering, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 72)

10:45 A.M.—"Preparation and Electrical Properties of Lead Sulfide" by W. W. Scanlon and R. F. Brebrick, U. S. Naval Ordnance Laboratory, White Oak, Md. (Abstract No. 73)

11:15 A.M.—"Semiconducting Films, II. InSb Films" by I. Dietrich and K. Lark-Horovitz, Department of Physics, Purdue University, Lafayette, Ind. (Abstract No. 74)

11:45 A.M.—"Periodic Relations in the Properties of Semiconducting Compounds" by R. W. Douglas, Research Laboratories, The General Electric Company, Inc., Wembley, England. (Abstract No. 75)

12:30 P.M.—Electronics Division Luncheon and Business Meeting in Parlor D (Mezzanine).

Electronics—Semiconductors (cont'd)

Intermetallic Compounds and Germanium and Silicon

with J. A. Burton presiding

(CENTURY ROOM, 19th floor)

2:00 P.M.—"Growth and Orientation of Crystals of the Diamond and Zinc Blende Type" by G. Wolff, Signal Corps Engineering Laboratories, Ft. Monmouth, N. J. (Abstract No. 76)

2:30 P.M.—"Crystallization of Silicon from a Floating Liquid Zone" by Paul H. Keck, Signal Corps Engineering Laboratories, Ft. Monmouth, N. J. (Abstract No. 77)

3:00 P.M.—"High Purity Silicon" by Felix B. Litton and Holger C. Andersen, Research and Development Laboratories, Foote Mineral Company, Berwyn, Pa. (Abstract No. 78)

3:30 P.M.—"Preparation and Properties of Germanium-Silicon Alloys" by C. C. Wang and B. H. Alexander, Electronics Division, Sylvania Electric Products Inc., Ipswich, Mass. (Abstract No. 79)

4:00 P.M.—"Semiconducting Films, I. Germanium Films" by M. Becker and K. Lark-Horovitz, Department of Physics, Purdue University, Lafayette, Ind. (Abstract No. 80)

4:30 P.M.—"Preparation of *N-P*-Junctions in Germanium by Surface Melting, and Their Electrical Properties" by K. Lehovec, A. Webb, and R. Zuleeg, Sprague Electric Company, North Adams, Mass. (Abstract No. 81)

Thursday, May 6, 1954

Electronics—Semiconductors (cont'd)

Germanium and Silicon

with J. R. Musgrave presiding

(CENTURY ROOM, 19th floor)

9:00 A.M.—"Electrolytic Stream Etching of Germanium" by Miles V. Sullivan, Bell Telephone Laboratories, Inc., Murray Hill, N. J. (Abstract No. 82)

9:30 A.M.—"A Study of the Etching Rate of Single Crystal Germanium" by Paul R. Camp, RCA Laboratories Division, Radio Corporation of America, Princeton, N. J. (Abstract No. 83)

10:00 A.M.—"Investigations of Surface Recombination Velocities on Germanium by the Photo-Electromagnetic Method" by T. M. Buck and W. H. Brattain, Bell Telephone Laboratories, Inc., Murray Hill, N. J. (Abstract No. 84)

10:30 A.M.—"On the Behavior of Rapidly Diffusing Acceptors in Germanium" by F. van der Maesen and J. A. Brenkman, Philips Research

Laboratories, N. V. Philips' Gloeilampenfabrieken, Eindhoven, Holland.
(Abstract No. 85)

11:00 A.M.—"Ultrasonic Attenuation Measurements in Germanium and Silicon Single Crystals" by A. Granato and Rohn Truell, Brown University, Providence, R. I.
(Abstract No. 86)

11:30 A.M.—"Electrical Properties of Microscopic Crystals of Boron and Germanium" by Wm. C. Shaw, Midwest Research Institute, Kansas City, Mo. (Abstract No. 87)

Semiconductor Devices and Other Semiconductors

with Paul H. Keck presiding

(CENTURY ROOM, 19th floor)

2:00 P.M.—" 'Stabilized Breakdown' Phenomenon in Selenium Rectifiers" by A. C. English, P. J. Colleran, A. Just, and W. H. Tobin, General Electric Company, Schenectady, N. Y.
(Abstract No. 88)

2:30 P.M.—"The Evaluation of New Semiconductors for Transistors and Application to Gallium Antimonide" by D. A. Jenny, RCA Laboratories Division, Radio Corporation of America, Princeton, N. J. (Abstract No. 89)

3:00 P.M.—"The Photoconduction of Zinc Oxide: A Study of Chemisorption" by P. H. Miller, Jr., and D. A. Melnick, Randal Morgan Laboratory of Physics, University of Pennsylvania, Philadelphia, Pa. (Abstract No. 90)

3:30 P.M.—"Titanium Dioxide Rectifiers: Production Methods and Electrical Properties" by T. S. Shilliday and C. S. Peet, Battelle Memorial Institute, Columbus, Ohio.
(Abstract No. 91)

4:00 P.M. — "Germanium Area Photovoltaic Cells" by Edward Simon, Department of Physics, Purdue University, Lafayette, Ind.
(Abstract No. 92)

4:30 P.M.—"Stabilization and Matching of Germanium Diodes for Military Applications" by W. F. Haldeman, Navy Department, U. S. Naval Ordnance Plant, Indianapolis, Ind.
(Abstract No. 93)

ELECTROTHERMICS

Tuesday, May 4, 1954

The Electric Arc Furnace
(Excluding Steel Making)
A. C. Haskell, Jr., General Chairman

Section I—Design and Construction

with E. T. Johnson presiding

(ILLINOIS ROOM, Mezzanine)

9:15 A.M.—Various types of furnaces such as the tilting, rotating hearth, submerged arc, and inert atmosphere types will be described as used for making ferrous and nonferrous alloys and other nonferrous products, both in this country and in Europe. The major features of each will be presented and discussed. Important factors influencing the design and choice of the arc furnace will be considered.

12:30 P.M.—Society Luncheon and Annual Business Meeting in the Grand Ballroom.

Electrothermics (cont'd)

The Electric Arc Furnace (cont'd)
(Excluding Steel Making)

Section II—Electrical Equipment

with J. J. Pannabaker presiding

(ILLINOIS ROOM, Mezzanine)

2:00 P.M.—With a simplified wiring diagram as a background, papers will be presented on the three major components of the electrical system, namely, (*a*) breakers, (*b*) transformers, and (*c*) controls. In addition to the description of the assemblies and subassemblies, the function and interrelationship of each will be discussed with special emphasis given to the very severe conditions imposed by the rapidly and widely fluctuating load.

Wednesday, May 5, 1954

Electrothermics (cont'd)

The Electric Arc Furnace (cont'd)
(Excluding Steel Making)

Section III—Electrodes

with John A. Shaw presiding

(CHICAGO ROOM, Mezzanine)

9:15 A.M.—Following a brief description of the

three major types of electrodes (amorphous carbon, graphite, and Soderberg) and their manufacture, the characteristics of each type will be discussed, with special reference to current-carrying capacity and the effects of different shapes. The papers will deal additionally with electrical, thermal, and weight losses, showing how and why they occur and suggested methods for minimizing.

Electrothermics (cont'd)

The Electric Arc Furnace (cont'd)
(Excluding Steel Making)

Section IV—Applications

with Gordon R. Finlay presiding

(CHICAGO ROOM, Mezzanine)

11:00 A.M.—This section will deal with a few of the products manufactured in the arc furnace. Some of the reactions going on in the furnace and the nature of the reactants or products will be described.

2:00 P.M.—Section IV—Applications continued.

Electrothermics (cont'd)

The Electric Arc Furnace (cont'd)
(Excluding Steel Making)

Section V—Theory of Arcs

with George W. Healy presiding

(CHICAGO ROOM, Mezzanine)

2:45 P.M.—The nature and characteristics of the arc will be reviewed briefly, including a discussion of the various phenomena at the cathode and anode and in the arc column itself. In addition to the theoretical aspects, experimental work will be presented relating to the wave forms of the arc current and voltage and their dependence on the arc atmosphere and electrode composition.

Thursday, May 6, 1954

Joint Session

ELECTROTHERMICS—RARE METALS

Refractory Compounds

with J. H. Westbrook presiding

(LINCOLN ROOM, 18th floor)

9:00 A.M.-12:00 M.—See p. 15 for papers on the

Joint Session with Electronics-Rare Metals.

12:30 P.M.—Electrothermic Division Luncheon and Business Meeting in the Chicago Room (Mezzanine).

Joint Session (cont'd)

Electrothermics—Rare Metals (cont'd)

Refractory Metals

with A. U. Seybolt presiding

(LINCOLN ROOM, 18th floor)

2:00-5:30 P.M.—See p. 16 for the papers on the Joint Session with Rare Metals.

INDUSTRIAL ELECTROLYTIC

Monday, May 3, 1954

with Frederick W. Koerker presiding

(CENTURY ROOM, 19th floor)

9:30 A.M. — "Explosive Limits of Hydrogen-Chlorine Mixtures" by A. W. Umland, The Dow Chemical Company, The Texas Division, Freeport, Texas. (Abstract No. 94)

9:50 A.M.—"Diaphragm Type Amalgam Caustic-Chlorine Cell" by Charles Potter and A. L. Bisio, Department of Chemical Engineering, Columbia University, New York, N. Y. (Abstract No. 95)

10:10 A.M.—"The *p*H in Chlorine-Caustic Electrolysis by the Mercury Cell Process" by Lars Barr, Division of Applied Electrochemistry, Royal Institute of Technology, Stockholm, Sweden. (Abstract No. 96)

10:30 A.M.—"The Effect of Impurities in the Electrolysis of Sodium Chloride Solution by Mercury Process" by Shinzo Okada and Shiro Yoshizawa, Department of Industrial Chemistry, Faculty of Engineering, Kyoto University, Yosida, Kyoto, Japan. (Abstract No. 97)

10:50 A.M.—"Several Problems Concerning the Current Distribution in the Industrial Electrolyzer" by Shinzo Okada, Shiro Yoshizawa, and Fumio Hine, Department of Industrial Chemistry, Faculty of Engineering, Kyoto University, Yosida, Kyoto, Japan. (Abstract No. 98)

11:10 A.M.—"Continuous and Uniform Generation of Stibine; An Electrolytic Apparatus and

Method" by Arnold Reisman, Melvin Berkenblit, E. C. Haas, and Allison Gaines, Jr., Material Laboratory, New York Naval Shipyard, Brooklyn, N. Y. (Abstract No. 99)

11:30 A.M.—"An Electrolytic Cell for Regeneration of Chromic Acid" by J. D. Fitzpatrick and R. P. Rolfes, Emery Industries, Inc., Cincinnati, Ohio. (Abstract No. 100)

12:30 P.M. — Industrial Electrolytic Division Luncheon and Business Meeting in the Chicago Room (Mezzanine).

Industrial Electrolytic (cont'd)

Round-Table Discussion

with Frederick W. Koerker presiding

(CENTURY ROOM, 19th floor)

2:00-5:00 P.M.—Summary of Chlorine-Caustic Production by W. C. Gardiner, Mathieson Chemical Corporation, Niagara Falls, N. Y.

Chlorine and Other Halogen Compression. R. B. MacMullin Associates, Niagara Falls, N. Y., will introduce the subject with an historical review, and they have contacted manufacturers and others to present 15-minute informal discussions of particular equipment. No formal papers for publication will be presented, and there will be no transcript of the meeting. The outline includes various phases of wet and dry chlorine gas compression, liquid chlorine pumping, and compression of other halogen gases. Discussions on hydraulic compression; diaphragm, sulfuric acid seal, and nonlubricated reciprocating compressors; liquid ring seal compressors; centrifugal machines; and ejectors are suggested phases. Discussions and questions from the floor will be invited.

Tuesday, May 4, 1954

Industrial Electrolytic (cont'd)

Molten Bath Electrolysis

with Frederick W. Koerker presiding

(CENTURY ROOM, 19th floor)

9:00 A.M. — Introduction — **"Fused Salt Electrolysis"** by Seymour Senderoff, Electrodeposition Section, Division of Chemistry, National Bureau of Standards, U. S. Department of Commerce, Washington, D. C. (Abstract No. 101)

9:20 A.M.—"Cathode Processes in Aluminum Reduction" by Morris Feinleib, Kaiser Aluminum & Chemical Corporation, Permanente, Calif. (Abstract No. 102)

9:40 A.M.—"Electrical Conductivity and Density of Molten Cryolite with Additives" by Junius D. Edwards, Cyril S. Taylor, Lee A. Cosgrove, and Allen S. Russell, Aluminum Research Laboratories, Aluminum Company of America, New Kensington, Pa. (Abstract No. 103)

10:00 A.M.—"Baths of Low Alumina Concentration in the Electrolysis of Aluminum" by Y. Doucet, Faculty of Sciences, Dijon University, Paris, France, L. Ferrand, Consulting Engineer, Paris, France, and F. V. Andreae, 351 Derby Circle, Chattanooga, Tenn. (Abstract No. 104)

10:20 A.M.—"The Extractive Metallurgy of Zirconium by the Electrolysis of Fused Salts, II. Process Development of the Electrolytic Production of Zirconium from K_2ZrF_6" by M. A. Steinberg, M. E. Sibert, and E. Wainer, Horizons Incorporated, Cleveland, Ohio. (Abstract No. 105)

10:40 A.M.—"The Extractive Metallurgy of Zirconium by the Electrolysis of Fused Salts, III. Large Scale and Pilot Plant Production" by B. C. Raynes, E. Theilmann, M. A. Steinberg, and E. Wainer, Horizons Incorporated, Cleveland, Ohio. (Abstract No. 106)

11:00 A.M.—"The Electrolytic Preparation of Molybdenum from Fused Salts, II. Preparation of Reduced Molybdenum Halides" by Seymour Senderoff and Abner Brenner, Electrodeposition Section, Division of Chemistry, National Bureau of Standards, U. S. Department of Commerce, Washington, D. C. (Abstract No. 107)

11:20 A.M.—"The Electrolytic Preparation of Molybdenum from Fused Salts, III. Studies of Electrode Potentials" by Seymour Senderoff and Abner Brenner, Electrodeposition Section, Division of Chemistry, National Bureau of Standards, U. S. Department of Commerce, Washington, D. C. (Abstract No. 108)

11:40 A.M.—"The Electrolytic Preparation of Molybdenum from Fused Salts, IV. Preparation of Reduced Molybdenum Halides from Molybdenite Concentrate" by Seymour Send-

eroff and Roger J. Labrie, Electrodeposition Section, Division of Chemistry, National Bureau of Standards, U. S. Department of Commerce, Washington, D. C. (Abstract No. 109)

Industrial Electrolytic (cont'd)

Molten Bath Electrolysis (cont'd)

Titanium

with Frederick W. Koerker presiding

(CENTURY ROOM, 19th floor)

2:00 P.M.—"Development of a Process for the Electrorefining of Titanium" by R. S. Dean and W. W. Gullett, Chicago Development Corporation, Riverdale, Md. (Abstract No. 110)

2:20 P.M.—"Electrode Reactions in the Refining of Titanium-Oxygen Alloys in Fused Chloride Baths" by R. S. Dean, W. W. Gullett, and Leo Goldenberg, Chicago Development Corporation, Riverdale, Md. (Abstract No. 111)

2:40 P.M.—"Preparation of Titanium by Electrolytic Reduction of the Reduced Oxides" by M. E. Sibert, Q. H. McKenna, M. A. Steinberg, and E. Wainer, Horizons Incorporated, Cleveland, Ohio. (Abstract No. 112)

3:00 P.M.—"Preparation of Titanium by Fluoride Electrolysis" by M. A. Steinberg, S. Carlton, M. E. Sibert, and E. Wainer, Horizons Incorporated, Cleveland, Ohio. (Abstract No. 113)

3:20 P.M.—"Anodic Behavior of Titanium in Fused Salt Baths" by M. E. Straumanis and A. W. Schlechten, Department of Metallurgical Engineering, University of Missouri, School of Mines and Metallurgy, Rolla, Mo. (Abstract No. 114)

3:40 P.M.—"Pyrosol Formation and Corrosion of Titanium in Fused Salts" by C. B. Gill, M. E. Straumanis, and A. W. Schlechten, Department of Metallurgical Engineering, University of Missouri, School of Mines and Metallurgy, Rolla, Mo. (Abstract No. 115)

4:00 P.M.—"Deposition of Titanium Coatings from Pyrosols" by A. W. Schlechten, M. E. Straumanis, and C. B. Gill, Department of Metallurgical Engineering, University of Missouri, School of Mines and Metallurgy, Rolla, Mo. (Abstract No. 116)

THEORETICAL ELECTROCHEMISTRY

Monday, May 3, 1954

Special Methods in Electrochemistry

with Paul Fugassi presiding

(ILLINOIS ROOM, Mezzanine)

9:30 A.M.—"Radio Tracer Studies of Electrolytic Action on Metal Surfaces" by Massoud T. Simnad, Metals Research Laboratory, Carnegie Institute of Technology, Pittsburgh, Pa. (Abstract No. 117)

10:00 A.M.—"Applications of Ultrasonic Waves in Theoretical Electrochemistry" by Ernest Yeager, Department of Chemistry, Western Reserve University, Cleveland, Ohio. (Abstract No. 118)

10:30-10:45 A.M.—Discussion.

10:45 A.M.—"Use of Isotopes in the Study of Ionic Hydration" by Henry Taube, Department of Chemistry, University of Chicago, Chicago, Ill. (Abstract No. 119)

11:15 A.M.—"Alternating Current Electrolysis" by A. E. Remick, Department of Chemistry, Wayne University, Detroit, Mich. (Abstract No. 120)

11:45 A.M.-12:00 M.—Discussion.

Theoretical Electrochemistry (cont'd)

Special Methods in Electrochemistry (cont'd)

with Ernest Yeager presiding

(ILLINOIS ROOM, Mezzanine)

2:00 P.M.—"Nuclear Magnetic Resonance as Applied to Electrolytic Solutions" by H. S. Gutowsky, Department of Chemistry, University of Illinois, Urbana, Ill. (Abstract No. 121)

2:30 P.M.—"Techniques for the Study of Hydrogen Electrode Kinetics" by J. O'M. Bockris, Department of Chemistry, University of Pennsylvania, Philadelphia, Pa. (Abstract No. 122)

3:00 P.M.—"Investigations of Equilibria in Concentrated Solutions by Means of Raman Spectra" by T. F. Young, Department of Chemistry, University of Chicago, Chicago, Ill. (Abstract No. 123)

3:30-3:45 P.M.—Discussion.

3:45 P.M.—"Current Interrupter Techniques in

the Study of Electrode Processes" by Sigmund Schuldiner, Naval Research Laboratory, Washington, D. C. (Abstract No. 124)

4:15 P.M.—"Application of Voltammetry at Constant Current to Electrochemical Studies" by Paul Delahay, Department of Chemistry, Louisiana State University, Baton Rouge, La. (Abstract No. 125)

4:45-5:00 P.M.—Discussion.

Tuesday, May 4, 1954

Theoretical Electrochemistry (cont'd)

with Ernest Yeager presiding

(GRAND BALLROOM, 19th floor)

9:00 A.M.—"Dissociation of Acids in Aqueous Solution" by T. G. Owe Berg, Avesta Jernverks Aktiebolag, Avesta, Sweden. (Abstract No. 126)

9:25 A.M.—"Heats of Formation and Entropies of HS^- and $S^=$. Potential of Sulfide-Sulfur Couple" by J. W. Kury, A. J. Zielen, and W. M. Latimer, Department of Chemistry and Chemical Engineering and Radiation Laboratory, University of California, Berkeley, Calif. (Abstract No. 127)

9:50 A.M.—"Electrolytic Oxidation of Zinc in Alkaline Solutions" by Thedford P. Dirkse, Department of Chemistry, Calvin College, Grand Rapids, Mich. (Abstract No. 128)

10:15 A.M.—"Evolution of Stibine at Antimony Cathodes" by H. W. Salzberg and A. J. Andreatch, Naval Research Laboratory, Washington, D. C. (Abstract No. 129)

10:40 A.M.—"Water Adsorption and Hydrogen Evolution" by H. W. Salzberg, Naval Research Laboratory, Washington, D. C. (Abstract No. 130)

11:05 A.M.—"Determination of Barrier Layer Thickness of Anodic Oxide Coatings" by M. S. Hunter and P. Fowle, Aluminum Research Laboratories, Aluminum Company of America, New Kensington, Pa. (Abstract No. 131)

11:30 A.M.—"Factors Affecting the Formation of Anodic Oxide Coatings" by M. S. Hunter and P. Fowle, Aluminum Research Laboratories, Aluminum Company of America, New Kensington, Pa. (Abstract No. 132)

THEORETICAL ELECTROCHEMISTRY (cont'd)

Theoretical Electrochemistry (cont'd)

with Paul Delahay presiding

(GRAND BALLROOM, 19th floor)

2:00 P.M.—"Measurement of Electrolytic Conductivity by Ballistic Galvanometer and Condenser: Applied to Aniline" by G. W. Thiessen and Students, Department of Chemistry, Monmouth College, Monmouth, Ill. (Abstract No. 133)

2:25 P.M.—"Hydrogen Overvoltage on Bright Platinum, II. pH and Salt Effects in Acid, Neutral, and Alkaline Solutions" by Sigmund Schuldiner, Electrochemistry Branch, Naval Research Laboratory, Washington, D. C. (Abstract No. 134)

2:50 P.M.—"Effect of Solvents and Electrolytes on Polarograms of Carbon Tetrachloride" by Johan J. Lothe and L. B. Rogers, Department of Chemistry and Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 135)

3:15 P.M.—"Ionic Mass Transfer and Concentration Polarization at Rotating Electrodes" by M. Eisenberg, C. W. Tobias, and C. R. Wilke, Department of Chemistry and Chemical Engineering, University of California, Berkeley, Calif. (Abstract No. 136)

3:40 P.M. — "Electrochemical Polarization of Zirconium in Distilled Water" by Norman Hackerman and Otto L. Willbanks, Jr., Department of Chemistry, University of Texas, Austin, Texas. (Abstract No. 137)

4:05 P.M.—"Mechanism of the Copper-Arsenic Method of Purifying Zinc Sulfate Electrolyte" by G. R. Van Houten and L. E. Stout, School of Engineering, Washington University, Seattle, Wash. (Abstract No. 138)

4:30 P.M.—"Electrodeposition of Alkali Metals from Nonaqueous Solutions" by Harry C. Mandell, Jr., Wallace M. McNabb, and J. Fred Hazel, Department of Chemistry, University of Pennsylvania, Philadelphia, Pa. (Abstract No. 139)

Wednesday, May 5, 1954

Theoretical Electrochemistry (cont'd)

with Paul Delahay presiding

THEORETICAL ELECTROCHEMISTRY
(cont'd)

(GRAND BALLROOM, 19th floor)

9:00 A.M.—"Potentiometric Titration of Simple Salts with Potassium in Liquid Ammonia" by George W. Watt, Gregory R. Choppin, and James L. Hall, Department of Chemistry, University of Texas, Austin, Texas. (Abstract No. 140)

9:25 A.M.—"Potentiometric Titration of Ammines of Rhodium, Iridium, and Platinum with Solutions of Potassium and Potassium Amide in Liquid Ammonia" by George W. Watt, Gregory R. Choppin, and James L. Hall, Department of Chemistry, University of Texas, Austin, Texas. (Abstract No. 141)

9:50 A.M. — "Hydrogen Overvoltage Measurements on Platinum and Platinum Alloys" by Gerald Lozier, Ernest Yeager, and Frank Hovorka, Department of Chemistry, Western Reserve University, Cleveland, Ohio. (Abstract No. 142)

10:15 A.M.—"Effect of Ultrasonics on Electrode Processes" by A. L. Ferguson, L. O. Case, F. A. Reiss, and S. H. Dreisbach, Department of Chemistry, University of Michigan, Ann Arbor, Mich. (Abstract No. 143)

10:40 A.M.—"Effects of Ultrasonic Waves on Concentration Gradients at Electrodes" by Robert Penn, Ernest Yeager, and Frank Hovorka, Department of Chemistry, Western Reserve University, Cleveland, Ohio. (Abstract No. 144)

11:05 A.M.—"Hydrogen Overvoltage in Phosphate and Ammonium Buffers" by William Van Dusen, Jr., Alma Elizabeth Chick, and Andre J. deBethune, Department of Chemistry, Boston College, Chestnut Hill, Mass. (Abstract No. 145)

11:30 A.M.—"Some Properties of Tin-II Sulfate Solutions and Their Role in Electrodeposition of Tin, III. Solutions with Tin-II Sulfate, Sulfuric Acid, and Addition Agents" by C. A. Discher, College of Pharmacy, Rutgers University, State University of New Jersey, Newark, N. J. (Abstract No. 146)

ABSTRACTS

ELECTRIC INSULATION

ABSTRACT NUMBER 1

EXPERIMENTS CONCERNING THE INFRARED GONIOMETRIC REFLECTANCE CHARACTERISTICS OF METALLIC SURFACES

John T. Agnew, Richmond B. McQuistan, and Leon L. Deer

MEASUREMENTS have been made of infrared goniometric reflectance characteristics of various metallic surfaces. Samples consisted of solid metallic surfaces, which have been treated in various ways to vary surface roughness, metallic powders, and filings, which have been screened to various sizes. Various thicknesses of different material were electroplated, anodized, and evaporated onto the surfaces. Correlation has been made between surface conditions and the goniometric characteristics of the target. A description will be given of the apparatus and techniques used to obtain these measurements. A globar, operated at 1330°K, was used as an infrared source. Goniometric reflectance characteristics of the sampler in various regions of the infrared spectrum were studied by means of quartz and calcium fluoride filters. The relationship of these measurements to the reflection from a perfectly diffuse infrared standard will be discussed.

ABSTRACT NUMBER 2

PARAMAGNETIC RESONANCE WITH SOME APPLICATIONS TO PROBLEMS IN CHEMISTRY AND PHYSICS

Clyde A. Hutchison, Jr.

THE paramagnetic resonance absorption phenomenon will be discussed, beginning with simple principles. Applications of magnetic resonance techniques to problems in chemistry and physics, including various researches in solid state physics, will be discussed.

ABSTRACT NUMBER 3

REDUCTION OF OXIDATION-IONS IN HYDROCARBONS

Andrew Gemant

THE formation of oxidation-ions, resulting from oxidation of aromatic orthodihydroxyl compounds in hydrocarbons, is shown to be either completely or partially reversible upon reduction. Compounds studied were catechol, butylcatechol, and 1-2 naphthalenediol. Among the oxidizing agents, ozone was studied in greater detail. Reduction was carried out by hydrogen gas at atmospheric pressure and room temperature. From the easy reversibility, it appears that a large fraction of the ions are relatively simple molecules. Their possible structure, formed by means of hydrogen bonding, is indicated. Ortho derivatives of aromatics containing additional side-chains are most likely to be parents of oxidation-ions.

ABSTRACT NUMBER 4

ELECTROSTATIC PROPERTIES OF CHARGED DIELECTRIC SHEETS

H. T. McLean

DIELECTRIC sheets in multiple layers were charged by frictioning with unlike dielectric materials. The sheets adhere strongly to one another, and, when separated, are attracted to one another even though they were found to be charged to the same polarity. An analysis of this behavior is presented, and the methods (and difficulties) of measurement are described. Related practical problems in the widely growing use of high resistivity plastic films and fibers are discussed.

ABSTRACT NUMBER 5

TRANSFORMER OIL: PROPERTIES OF NAPHTHENIC AND AROMATIC FRACTIONS

R. Nichols Hazelwood, Raymond M. Frey, and Joanne B. Broecker

TRANSFORMER oil can be separated into naphthenic and aromatic fractions by percola-

tion through silica gel. The following properties of the fractions have been determined: d-c conductivity, viscosity, viscosity index, interfacial tension, acid number, steam emulsion number, refractive dispersion, and molecular type. The behavior of these fractions in an arc is discussed with reference to the formation of gases, the production of carbon, and the structural changes of the molecules of the fractions.

ABSTRACT NUMBER 6

DIELECTRIC DISPERSION OF MIXTURES OF CHLORINATED BIPHENYLS WITH TRICHLOROBENZENE AND WITH DIPHENYL ETHER

Robert J. Good

STUDIES have been made of the dielectric constant and dissipation factor, as functions of temperature and frequency, for mixtures of Aroclors (chlorinated biphenyls) with trichlorobenzene and with diphenyl ether. Effects of concentration on distribution of relaxation times are examined for the two diluents. Differences resultant from the varied shapes, sizes, and polarities of the molecules are discussed.

ABSTRACT NUMBER 7

STABILIZATION OF DIELECTRICS

D. A. McLean

THIS talk reviews work done in the Bell Laboratories and other places over the past several years on the stabilization of dielectrics. Stabilizers have found their principal practical use in paper capacitors, where addition of a small amount may increase the life under a given set of conditions by 10- to 100-fold. Some dielectrics which would ordinarily be unsuitable as capacitor impregnants are made practical by incorporation of stabilizers. Effective stabilizers include the quinones, nitroaromatics, benzil, azo- and azoxy-compounds, and sulfur. Anthraquinone has had the widest commercial use.

Recent studies show that stabilizers have a favorable influence on dielectric strength of oils and oil-impregnated capacitors in addition to their effect on life.

The most recent work on the mechanism of stabilization has been based on a study of gassing

under electrical stress. This work indicates that the deterioration of insulating liquids under electrical field is associated with free radical fragmentation, followed by reaction of these fragments with themselves and with molecules of the liquid. Stabilizers appear to owe their effectiveness to their ability to react rapidly with the free radicals formed in the primary breakdown step.

ABSTRACT NUMBER 8

ELECTRICAL PROPERTIES OF COMMERCIAL LIQUID DIELECTRICS

Thomas D. Callinan

CHANGES in free energy and entropy caused by the application of an electric field to transformer oil, silicone oil, castor oil, trichlorobenzene, and pentachlorodiphenyl have been determined. Molar polarizations and dipole moments of these materials have been found also.

ABSTRACT NUMBER 9

RECENT DEVELOPMENTS IN INTEGRATED MICA

M. D. Heyman

THE fact that catalytic effects are obtainable within the pores of integrated mica opens new possibilities of using impregnants that were hitherto considered impossible of usage; new effects are obtainable with considerable increase in strength to the material. Thus, mica can be made porous and, at the same time, highly resistant to most liquids including acids and, in particular, aqueous solutions.

ABSTRACT NUMBER 10

ELECTRICAL PROPERTIES OF 'ARALDITE' ETHOXYLINE RESINS

M. Wismer and J. Durra

CHEMICAL, electrical, and mechanical properties of certain ethoxy-type polymers are described. Techniques for their successful use as casting resins are presented. Results of use in actual electronic component and miniaturization applications are given.

ABSTRACT NUMBER 11

DU PONT 'MYLAR' POLYESTER FILM, A NEW AND VERSATILE ELECTRICAL INSULATION

J. A. Ruby

CHEMICAL, electrical, and physical properties of the polyester film are presented together with uses of the material in capacitors, motors, generators, transformers, wire, and cable.

ABSTRACT NUMBER 12

'BAKELITE' CELLULAR POLYETHYLENE

W. T. Higgins

THE preparation and uses of cellular polyethylene as wire insulation are disclosed, together with physical and electrical properties of the material.

ABSTRACT NUMBER 13

APPLICATIONS OF ISOCYANATES IN THE ELECTRICAL INDUSTRY

J. H. Saunders and Edgar E. Hardy

PRINCIPAL uses of isocyanates in the electrical industry are in the fields of coatings, foams, and potting compounds. The fundamental chemistry of the isocyanate reactions with polyesters, polyamides, and glycols for these applications is reviewed. This review includes reactions of isocyanate groups with functional groups of the polymers which are modified, such as the hydroxyl and carboxyl groups of polyesters, with water, which frequently is present as an impurity, and with the resulting substituted urea and urethan groups.

One of the most promising materials for the wire coating industry is a polymer from tolylene diisocyanate, trimethylolpropane, and a polyester. Typical electrical properties of such a polymer are a dielectric constant of 4 to 5, specific resistance of 10^{15} ohm-cm, power factor of 0.01, and a dielectric strength of 3500 volts per mil.

The preparation of a potting compound from tolylene diisocyanate and castor oil has been reported. Electrical properties of this material were

adequate for low frequency applications: dielectric constant, 4.57, power factor, 0.174, both at 1 kilocycle, and 340 volts per mil dielectric strength.

The rigid isocyanate-polyester foams are outstanding for the preparation of radomes. In addition to the necessary physical strength, these foams have excellent dielectric properties: at 9160 megacycles, the dielectric constant is 1.2 and the power factor is 0.004.

A variety of other applications of interest to the electrical industry is reviewed briefly.

ABSTRACT NUMBER 14

NEW CASTING RESINS FOR MINIATURIZATION

P. Rector

MINIATURIZATION has placed new demands on the plastics industry to develop casting resins of exceptional dielectric qualities. A number of such items possessing high dielectric strength, exceptional moisture resistance, and good thermal stability have been developed. These materials are now available commercially and have been found to possess excellent shelf life and relative ease in handling. They set to hard, bubble-free products with a minimum of detail. Outstanding are their low shrinkage and their high resistance to corrosive chemicals.

ABSTRACT NUMBER 15

AGING CHARACTERISTICS OF CLASS 'H' INSULATION

Edwin Lotz

THIS paper deals with the latest silicone resins, rubber, and 'Teflon' products which have been made available for use as coating materials for electrical insulation. Basic test information, followed by aging tests and results under severe heat conditions, will be presented.

ABSTRACT NUMBER **16**

MORE ADVANTAGEOUS USE OF LAYER INSULATIONS FROM THICKNESS-DIELECTRIC STRENGTH RELATIONSHIPS

Paul Doigan

THE thickness-dielectric breakdown and thickness-dielectric strength relationships for various Class B and H layer insulation materials have been investigated. Mathematical relationships can be written in the form of exponential equations, $KV = AT^b$. It is found that three distinct groups of materials occur, characterized by the slopes of the logarithmic plots. Of the materials investigated (eleven in all), the thickness of polyester-impregnated Quinterra paper has the least effect on the dielectric strength (VPM) while a specially prepared untreated Quinterra paper shows the greatest thickness-dielectric strength variations. The information is valuable in that it affords a basis for more complete utilization of a layer insulation material by taking some of the guesswork out of the safety factor.

ABSTRACT NUMBER **17**

SURVEY OF ARC-RESISTANCE AND TRACKING CHARACTERISTICS OF PLASTICS

W. C. Wikstrand and C. F. Spiers

AN evaluation of arc resistance, in terms of the chemistry and physics of plastics, is presented.

ABSTRACT NUMBER **18**

EFFECT OF MOISTURE, TEMPERATURE, AND FREQUENCY ON THE ELECTRICAL PROPERTIES OF INSULATING MATERIALS

L. J. Frisco

RESULTS of a study of the effect of temperature and moisture absorption on electrical properties of a representative group of materials will be discussed. Data on dielectric strength, flashover strength, dielectric constant, and dissipation factor, in the frequency range from 60

cycles to 100 megacycles, will be presented. Special emphasis will be placed on the importance of dielectric strength values in the frequency range from 1000 cycles to 100 megacycles.

ABSTRACT NUMBER 19

BREAKDOWN PHENOMENA AS RELATED TO OTHER DIELECTRIC PROPERTIES

J. J. Chapman

AS A result of investigations over a wide frequency range, the author attempts to relate dielectric breakdown with other dielectric phenomena.

ABSTRACT NUMBER 20

REVIEW OF METAL-CERAMIC SEALS

Hayne Palmour, III

A CRITICAL discussion is given of various methods used today for making pressure and vacuum tight metal-ceramic seals.

ABSTRACT NUMBER 21

REVIEW OF HIGH TEMPERATURE INSULATIONS INCLUDING VARNISHED CLOTHS, MICA PAPER, AND OTHER SHEET MATERIALS

A. J. Sherburne and R. W. Staley

THIS paper, in the nature of a summary of properties required for high temperature insulation for electrical apparatus, describes and compares several of the newer types of materials such as varnishes, varnished glass laminates, synthetic sheet materials, mica, and mica paper as to their advantages and disadvantages and their expected fields of application.

ELECTRONICS—INSTRUMENTATION

ABSTRACT NUMBER **22**

STABILIZED POWER SUPPLIES FOR INSTRUMENT APPLICATIONS

W. G. Amey, F. H. Krantz, W. R. Clark, and A. J. Williams, Jr.

FOR many instruments involving precise measurement, d-c supplies are needed for lamps, photocells, d-c amplifiers, potentiometers, etc., where batteries are either undesirable or inadequate. Stabilized d-c supplies meeting some of these needs are described, along with the methods found most effective in dealing with such items as the voltage standard, zero drift in the control amplifier, line transients, adjustment of output voltage, supplying 1500 volts with very close regulation for photomultiplier tubes, etc.

ABSTRACT NUMBER **23**

HIGH-FREQUENCY INSTRUMENTATION

J. C. Clayton, J. Fred Hazel, Wallace M. McNabb, and G. L. Schnable

THE present work was undertaken to overcome disadvantages of the limited concentration range and sensitivity to temperature variations of high-frequency measurements. Instruments which respond to either effective capacitance or effective conductance changes were used. A cell was designed to minimize the dielectric constant contribution of the solution and to respond only to conductance. Studies on the significance of physical dimensions of high-frequency titration cells were carried out. Progressively varying the electrode separation distance or the diameter of the titration vessel shifted the useful concentration regions of response curves. Increasing the length of metal electrodes magnified the response of effective concentration regions. Constant-temperature systems were devised to permit both aqueous and nonaqueous liquids to be used as circulating media.

ABSTRACT NUMBER **25**

MEASUREMENT OF FLUORESCENCE DECAY TIMES

S. H. Liebson

FLUORESCENCE decay times in organic scintillation materials have been measured at this laboratory by three different methods. Decay times due to gamma ray excitation were determined by means of a method involving pulse reflections from a shorted cable. Ultraviolet stimulated fluorescence decay times were measured with a high-frequency fluorometer, and checked by a method useful only for liquids, based on the depolarization of fluorescence. The time resolution of these methods varied from about 2×10^{-10} sec and longer depending on noise levels and statistical fluctuations.

ABSTRACT NUMBER **26**

MEASUREMENT OF COLOR UNIFORMITY OF BLACK AND WHITE KINESCOPE SCREENS

Austin E. Hardy

A METHOD has been developed which permits essentially an instantaneous appraisal of the color uniformity of the entire screen or at least of the defining areas of black and white kinescopes. The system employs a pair of blue- and yellow-responsive multiplier phototubes, signals from which are observed as horizontal and vertical deflections, respectively, on a conventional cathode ray oscilloscope. The novelty of the system lies in the use of vector presentation of the color information.

ABSTRACT NUMBER **27**

PHOTOELECTRIC TRISTIMULUS METHODS OF PHOSPHOR COLOR MEASUREMENT

Richard S. Hunter

TWO photoelectric tristimulus techniques for the colors of television picture tubes, fluorescent lamps, and the phosphors used in them will be described. One uses a single photocell and

three Hunter[1] type filters on a disk. Photocell currents corresponding to each of the three filters are converted by equations or nomographs to values of color. The second technique was first described by Barnes[2] and makes use of three or four photocells, each with different filters. Currents from these photocells are measured with a special current-balancing bridge which gives values of luminance and chromaticity directly. The writer has devised a new reversed-signal circuit which gives direct readings of chromaticity with improved sensitivity and stability.

Either type of photoelectric tristimulus device may be operated manually with a sensitive galvanometer as the detecting device, or it may be operated automatically with an industrial recorder modified to make the standardizing adjustments and plot the results.

[1]R. S. HUNTER, *J. Opt. Soc. Amer.*, **32**, 509 (1942).
[2]B. T. BARNES, *Rev. Sci. Inst.*, **16**, 337 (1945).

ELECTRONICS—LUMINESCENCE

ABSTRACT NUMBER 28

LUMINESCENCE FACTS AND FOIBLES

Humboldt W. Leverenz

(NO ABSTRACT AVAILABLE)

ABSTRACT NUMBER 29

HEAT TREATMENT OF ZINC SULFIDE SINGLE CRYSTALS

Alfred Kremheller

CRYSTALS grown in an atmosphere of noble gas have shown disorder of the crystal structure, consisting of randomness, mixed hexagonal-cubic structure in the same crystal, and the presence of polytypes of the hexagonal form. The crystallographic structure has been altered by heat treatment without destroying the single crystal nature. Annealing also changes physical color, luminescence behavior, and electrical resistance, properties which are related to the impurity content. Presence of chloride in the zinc sulfide powder in which the crystal is embedded during annealing has a pronounced influence on crystal structure and transition point.

ABSTRACT NUMBER 30

ADSORPTION OF PRECIPITATED ZINC SULFIDE FOR CHLORIDE AND SULFATE IONS

Dominic T. Palumbo and Albert K. Levine

DATA are presented to show that zinc sulfide precipitated from chloride or sulfate solutions retains from 0.2 to 2.0% chloride or sulfate ion after thorough washing. Ion exchange experiments show that sulfate contamination is mainly or entirely a surface phenomenon; results with chloride are not yet conclusive. Data show that the exchange is mainly anionic; only small quantities of zinc and hydrogen ions are displaced. Digestion of anion-contaminated sulfides for periods up to 528 hr in water at 70°C removes only a fraction of the contaminating anions; i.e., only 7% of the chloride ion is removed after 212 hr, and 20% of the sulfate after 528 hr.

ABSTRACT NUMBER 31

EXAMINATION OF THE ROLE OF FLUXES IN ZINC SULFIDE PHOSPHOR PREPARATION

Paul Goldberg and Albert K. Levine

VARIOUS interpretations of halide flux action in zinc sulfide phosphor preparation are reviewed. The literature may be classified according to the principal emphasis as to energy (physics), composition (chemistry), and structure (geometry). At least three features of flux action still remain to be investigated and correlated. They are: extent to which halide actually enters the ZnS lattice; effect of flux on the ZnS cubic-hexagonal transition; and mechanism and role of particle growth during firing. Attention will be called to apparent inconsistencies in the literature.

ABSTRACT NUMBER 32

SURFACE STATES OF CADMIUM SULFIDE

S. H. Liebson

PHOTOCONDUCTIVE and phosphorescent properties of cadmium sulfide are modified by presence of surface states due to adsorbed

molecules. The spectral response of photoconductivity, infrared effects, and time constant observations suggests that surface states aid in recombination and in enhancing infrared quenching of photoconductivity. The photovoltaic behavior of rectifying contacts lends credence to the hypothesis that infrared releases otherwise immobile holes.

ABSTRACT NUMBER 33

LUMINESCENCE OF ZINC SULFIDE PHOSPHORS

Laurence Burns

THE theory of charge compensation is useful in explaining certain properties of sulfide phosphors, and the effectiveness of trivalent metals as coactivators is often taken as confirming it. The theory has defects, and not all trivalent metals are coactivators. Effective coactivators are trivalent ionically but monovalent homopolarly, having only one unpaired electron. A covalent theory of luminescence on that basis is attempted and extended to cover known activation of zinc sulfide without coactivators.

ABSTRACT NUMBER 34

A MODEL FOR LUMINESCENCE AND CONDUCTIVITY IN SULFIDES

Clifford C. Klick and John Lambe

FOR sulfides activated by monovalent metals, a model is discussed which differs in several important respects from that usually employed. Because of the net negative charge of the lattice volume surrounding the activator there is a large cross section for trapping of holes which may be accompanied by release of a large amount of energy. This is presumed to be the transition leading to luminescence. A subsequent trapping of an electron returns the center to its original condition. For the electron trapping there is no Coulomb field and both the cross section and energy released would be expected to be small compared with the case of hole trapping. On the basis of this model, there is a simple explanation of the fast luminescence decay associated with holes and the slow conductivity decay associated with free electrons. Other well-known phenomena in the sulfides are examined on the basis of this model.

ABSTRACT NUMBER 35

TRAPPING IN ZnS:Cu:Co*

B. Goldstein and J. J. Dropkin

THE population and energy of the trapping states of ZnS:Cu 10^{-4}:Co 10^{-6} (hexagonal) was measured by thermoluminescence as a function of the time of ultraviolet excitation, of the time and temperature of spontaneous or *IR* forced decay, and of the per cent CdS in the base material. The main copper and cobalt peaks are shown to be complex, with only part of the copper peak *IR* sensitive. Phosphorescent behavior checks the glow curve data.

*Supported by Office of Naval Research Contract N6onr 26313.

ABSTRACT NUMBER 36

TEMPERATURE DEPENDENCE OF THE FLUORESCENCE OF ZnS PHOSPHORS

Spotswood D. Bowers, Jr.

TEMPERATURE dependence of the beta ray excited fluorescence of ZnS phosphors has been investigated. It is found that both rate and direction of change of temperature have a pronounced effect on the measurements. These effects have been investigated for varying intensity and type of excitation, including ultraviolet excitation.

ABSTRACT NUMBER 37

SOME ELECTROLUMINESCENT EFFECTS AND THEIR INTERPRETATION

Frank Matossi and Sol Nudelman

SQUARE wave fields and other nonsinusoidal fields applied to a Sylvania phosphor produce characteristic luminescence peaks and decays that are different for blue and green luminescence. Observations are interpreted by using the following assumptions: green luminescence involves transitions to conduction band and to traps; blue luminescence is due to transitions within a center; the effective field varies in time because of the development of polarization charges.

ABSTRACT NUMBER **38**

ELECTROLUMINESCENCE IN ZnS SINGLE CRYSTALS

W. R. Watson, A. T. Halpin, and J. J. Dropkin

OSCILLOGRAMS and photographs of a ZnS crystal electroluminescing under half-wave excitation show two emission processes both originating from the same region of the crystal, but differing in voltage dependence, emission characteristics, and phase delay with respect to voltage. The emission region is one of high potential drop and does not shift with change of polarity. A mechanism is proposed for these observations.

ABSTRACT NUMBER **39**

INCREASE OF LUMINESCENCE SENSITIVITY TO X-RAYS OF SOME MIXTURES OF ZINC SULFIDE AND CADMIUM SULFIDE UNDER THE ACTION OF ALTERNATING ELECTRIC FIELDS

G. Destriau

A DECREASE in the x-ray excited luminescence of certain phosphors when the material is subjected to an alternating electric field was first observed in 1943.[1] It has now been found that some mixtures of zinc and cadmium sulfides show an opposite effect. The brightness for the same intensity may be increased by a factor of three by applying fields of the order of 10^4 volts/cm.

[1] *J. Appl. Phys.*, **25**, January 1954.

ABSTRACT NUMBER **40**

ELECTROLUMINESCENT LAMPS USING GLASS DIELECTRICS

Richard M. Rulon

FOUR types of electroluminescent lamps using a glass dielectric are discussed, with specific reference to the different structural components of these types, e.g., conductive glass, conductive ceramic material, metal, and porcelain enamel. Lamps made using a glass dielectric on any one of these materials have good chemical and ther-

mal resistance. In addition, the metal and porcelain based lamps have good mechanical strength and ease of fabrication. Brightness, color, and life of these lamps also compare favorably with lamps using other dielectric materials.

ABSTRACT NUMBER 41

MODIFIED CALCIUM PYROPHOSPHATE PHOSPHORS

D. E. Kinney

THE preparation and optical properties of modified calcium pyrophosphate phosphors are described. Modification of the matrix by the partial substitution of sodium for calcium produces a considerable increase in luminous output. Activated by antimony, $(Ca,Na_2)_2P_2O_7$:Sb emits in the blue with high color purity. Activated by both antimony and manganese, a wide variety of fluorescent colors result, the exact color being dependent upon manganese concentration. Phosphors described are efficiently excited by both cathode rays and short wave length ultraviolet. Fluorescent lamps prepared with the proper $(Ca,Na_2)_2P_2O_7$:Sb:Mn phosphors have good luminous efficiencies, with colors ranging between 4500°K + 10 mpcd and 6500°K — 10 mpcd on the I.C.I. color mixture diagram.

ABSTRACT NUMBER 42

EMISSION SPECTRUM OF CaF_2: (Ce + Mn)

Robert J. Ginther

MANGANESE emission of the calcium fluoride phosphor activated by cerium and manganese has been found to be dependent upon concentration of both activator and sensitizer and upon the type of excitation employed. Variation in emission spectrum is shown to be due to the existence of several types of emitting centers. A wide variety of centers, consisting of combinations of singlets and aggregates of manganese coupled with singlets and aggregates of cerium, are shown to have different emission spectra. More complicated centers have the longer wave length emission.

ABSTRACT NUMBER 43

ANTIMONY OXIDE PHOSPHOR WITH RED EMISSION

Yoshihide Kotera and Tadao Sekine

A PHOSPHOR consisting of antimony oxide, boric oxide, and manganese activator is fairly efficiently excited by ultraviolet radiation. It emits a band spectrum with a peak at 6400 Å. The function of the boric oxide is to enhance the fluorescence intensity, the optimum composition being about 1 mole antimony oxide, 0.1 mole boric acid, and 0.002 mole manganese. Firing times, temperatures, and atmospheres (except hydrogen) are not critical. Structure of the phosphors is discussed on the basis of x-ray diffraction patterns.

ABSTRACT NUMBER 44

LANTHANUM OXYCHLORIDE PHOSPHORS

Frank E. Swindells

LANTHANUM oxychloride can be activated to show strong fluorescence under excitation by cathode rays. Bismuth as an activator gives a blue emission extending into the ultraviolet with the peak at 3580 Å, antimony a greenish white with the peak at 4960 Å, and samarium a reddish orange emission composed of a series of lines or narrow bands, the strongest of which are at 5640 Å, 5770 Å, 6060 Å, and 6510 Å. The phosphor activated with antimony has a blue emission when excited by 2537 Å.

ELECTRONICS—PHOSPHOR SCREEN APPLICATION

ABSTRACT NUMBER 45

SOME FACTORS AFFECTING SCREENING AND SCREEN STRENGTH IN CATHODE RAY TUBES

J. Fred Hazel and William Stericker

THERE are a number of factors which influence the formation of screens by the settling process. Variations in some of these factors have

been studied in the laboratory so as to guide larger scale tests and to try to develop the theory of screen formation. With barium salts there are optimum concentrations of potassium silicate solutions for strong screens and for the formation of turbidity. The best screens were obtained when barium salts were added to the cushion water. Slightly increased settling times gave markedly stronger screens. When the silicate solution has been frozen, it is more difficult to get good screens.

ABSTRACT NUMBER 46

INTERACTION OF BARIUM SALTS WITH POTASSIUM SILICATE SOLUTIONS

J. Fred Hazel, Wallace M. McNabb, and C. A. Crutchfield, Jr.

THE formation of screens by the settling process depends on inducing polymerization in silicate solutions with addition agents. The marked tendency of silicates to undergo polymerization opposes their tendency to form stoichiometric compounds with cations. In the persent study, barium salts have been titrated conductometrically with potassium silicate solutions under a variety of conditions in order to explore compound formation between these substances.

ABSTRACT NUMBER 47

A STUDY OF BARIUM AND SILICATE CONCENTRATIONS IN PHOSPHOR SCREEN APPLICATION

Russell B. Snyder and Leonard Maisel

A STUDY has been made of the effect of concentration variation of potassium silicate and barium actetate as affecting wet and dry screen adherence. Curves are given for Kasil No. 1, Du Pont and Kasil, 3.5 mole ratio, and Du Mont potassium water-glass.

ABSTRACT NUMBER 48

SECONDARY ELECTRON EMISSION OF ALL-SULFIDE PHOSPHOR SCREENS

G. P. Kirkpatrick

THE initial secondary electron emission of approximately 40 different all-sulfide phosphor screens was investigated by a pulse technique resembling that of Heydt and White at a primary electron energy of 20 kv. In most cases, phosphors were water-settled with potassium silicate as a binder on microscope cover glasses. The screens were baked out in air and then inserted into a demountable vacuum chamber. A pressure of not more than 3×10^{-5} mm Hg was obtained in the chamber before the secondary-electron-emission ratio, or delta, of any screen was determined.

ABSTRACT NUMBER **49**

USE OF SCREEN POTENTIAL MEASUREMENT EQUIPMENT IN EVALUATING CATHODE RAY TUBE SCREENS

T. V. Rychlewski and L. W. Evans

A BRIEF chronology to determine the need for screen potential measurements is outlined. "Spider" ("X," cross, etc.) burn is specifically considered. A general mechanism is postulated. Methods of measuring screen potential are discussed, and why the Nelson technique was chosen is explained. Equipment, with modifications, is outlined. Data on equipment are shown. Method of "accelerated" life is explained. Curves of various types of screens are shown and discussed. Explanation is given of how screen potential and "accelerated" life data are used for trends.

ABSTRACT NUMBER **50**

FILMING AND ALUMINIZING PROCESSES FOR CATHODE RAY TUBES

Channing Dichter and Vanja Srepel

THE various techniques that can be used to film cathode ray tubes will be discussed. Common defects and their cures are to be outlined. Physical parameters involved in introducing a thin layer of aluminum between the electron gun and the phosphor screen will be analyzed. The effect of aluminizing on spot-size contrast, light output, effective tube life, gas ratio, etc., will be reviewed.

ELECTRONICS-RARE METALS—ELECTROTHERMICS

ABSTRACT NUMBER 51

METALLIC COMPOSITES

J. Wulff

THIS paper attempts to relate structure and properties of metallic composites. Various physical and chemical properties of two-component composites prepared by powder metallurgy techniques are compared with the corresponding properties of components utilizing wire, ribbon, or sheet. Of the materials examined, molybdenum-copper composites received the most study, since the lack of appreciable alloying between these two metals simplified experimental work and theoretical considerations. It was found in all cases that deviation of measured values of properties from values predicted by a simple mixture law was highly dependent upon the structure of the composite.

ABSTRACT NUMBER 52

PREPARATION OF REFRACTORY COMPOUNDS HAVING CONTROLLED MICROSTRUCTURE

R. Atkinson, R. Read, and A. J. Shaler

EVIDENCE is shown that two-phase materials with tailor-made microstructures can reach high toughness values. Calculations for some structures are given. Results obtained from two-dimensional analogs photoelastically analyzed are presented. Techniques and equipment for making, selecting, sizing, and packing small spherical particles, and for impregnating compacts made therefrom, are described. Properties are evaluated for such compacts made from the following two-phase materials, glass with polystyrene, high-carbon steel with silver, molybdenum with silver, cermets, ceramals.

ABSTRACT NUMBER 53

TEMPERATURE DEPENDENCE OF HARDNESS OF THE EQUI-ATOMIC IRON GROUP ALUMINIDES

J. H. Westbrook

A SERIES of iron group aluminides, a typical group of intermetallic compounds, were prepared by arc melting and their hardness studied as a function of temperature and composition, using a modified Bergh instrument. FeAl-, CoAl-, and NiAl-based materials were studied up to 800°C and over the entire homogeneity range of each compound. Results appear to be related to the defect structure in such materials.

ABSTRACT NUMBER 54

DISILICIDES—NEW REFRACTORY ALLOYS

Roger A. Long

DISILICIDES are defined as a combination of a transition metal and silicon conforming to the approximate general formula RSi_2. Their characteristics which could make them a valuable engineering material are their inherent resistance to high temperature oxidation, their low specific gravity, and their strength at elevated temperatures. Their present characteristics which make them still a development material are their brittleness at room temperature, their low impact strength, and their poor resistance to thermal shock. Mechanical and physical properties are dependent on the choice of the transition metal, on the method of alloy preparation, and on the fabrication procedures of the powdered alloy.

ABSTRACT NUMBER 55

TITANIUM SILICIDE AS A REFRACTORY COATING

Stanley Kluz, Ralph Wehrmann, and L. F. Yntema

TITANIUM forms the thermally stable silicides, Ti_5Si_3 and $TiSi_2$, and an unstable TiSi which are oxidation resistant. Silicide coatings are prepared by heating a layer of elemental silicon on the titanium body to be protected. Coatings prolong the life of a specimen at 800°C about tenfold as compared with uncoated metal. The hard, brittle coatings are adherent and well bonded.

ABSTRACT NUMBER **56**

PHYSICAL PROPERTIES OF TRANSITION METAL DIBORIDES

Frank W. Glaser, David Moskowitz, and Benjamin Post

PRELIMINARY studies of many transition metal borides have indicated that some of these compounds have electrical and other physical properties of considerable technological and scientific importance. In this paper, results of measurements of physical properties of isomorphous diborides of transition metals of the 4th, 5th, and 6th Groups of the Periodic Table are reported, including density, hardness, specific heat, and coefficients of thermal and electrical conductivity. Efforts have been made to interpret some of these properties in terms of the structure of the diborides and of the parent metals.

ABSTRACT NUMBER **57**

PREPARATION AND CRYSTAL STRUCTURES OF SOME HIGH MELTING THORIUM-GERMANIUM COMPOUNDS

A. W. Searcy and A. G. Tharp

AN X-RAY diffraction investigation of the thorium-germanium phase diagram reveals the existence of five intermediate phases. Structures of two of these phases have been determined from their x-ray diffraction powder patterns. The size of their unit cells and their crystallographic symmetry establish that both phases must have ideal formulas of $ThGe_2$, although one of them was found in preparations having compositions of Th_2Ge_3. Space groups and unit cell dimensions of both phases are described, and their similarity to isostructural thorium-silicon and uranium-silicon phases is discussed.

ABSTRACT NUMBER **58**

RESISTANCE SINTERING UNDER PRESSURE OF REFRACTORY MATERIALS

F. V. Lenel

RESISTANCE sintering under pressure is a method of hot pressing in which a low

voltage, high amperage current is passed through a powder compact and pressure is applied simultaneously. It is of particular interest in hot pressing refractory metals and ceramic powders since only the powder, but not the die, is heated by the sintering current, and sintering times are very short. Some applications of the method to cermets are presented.

ABSTRACT NUMBER **59**

ELECTROTHERMAL HEATING OF SOLUTIONS*

Kenneth A. Kobe and Carl J. Carlson

FOR heating and evaporation of concentrated solutions of electrolytes, the solution itself can serve as a resistor to give uniform heating throughout. Solutions of salts having a negative temperature coefficient of solubility can be concentrated by electrical heating, provided electrodes are maintained at a temperature below that of the solution. Experimental details are given for solutions of sodium sulfate. The electrical conductivity of saturated solutions of Na_2SO_4, Na_2CO_3, Na_3PO_4, and $MgSO_4$ has been determined from 25° to 75° or 90°C.

*The experimental work reported here was conducted in the laboratories of the Department of Chemical Engineering, University of Washington, Seattle, Wash.

ABSTRACT NUMBER **60**

DETERMINATION OF THE GAS CONTENT OF METALS OF HIGH PURITY BY VACUUM FUSION

M. W. Mallett

TYPICAL gas contents, as determined by vacuum-fusion techniques, are given for a number of "high purity" metals. Since many of these metals have high melting points, are carbide formers, and show a strong gettering ability at elevated temperatures, the general vacuum-fusion technique has been modified for application to these metals.

ABSTRACT NUMBER 61

AN INVESTIGATION OF THE HYDROGEN CHLORIDE VOLATILIZATION METHOD FOR THE ANALYSIS OF OXYGEN IN ZIRCONIUM

Russell H. Atkinson

(NO ABSTRACT AVAILABLE)

ABSTRACT NUMBER 62

RECENT INVESTIGATIONS IN THE CONTROL AND OPERATION OF ZIRCONIUM PRODUCTION FURNACES

F. E. Block and A. D. Abraham

A GENERAL outline of the Kroll process for the production of zirconium sponge is presented. Recent trends in automatic furnace control and instrumentation are reported. Attempts have been made to streamline production through modification of furnace operations and are discussed in terms of sponge quality.

ABSTRACT NUMBER 63

CRYSTAL STRUCTURE AND THERMODYNAMIC STUDIES ON ZIRCONIUM-HYDROGEN ALLOYS

Earl A. Gulbransen and Kenneth F. Andrew

TWO major hydride phases are formed at low temperatures, the ε phase of Hägg[1] having a range of homogeneity of $ZrH_{1.64}$ to $ZrH_{1.965}$ and the δ phase of Hägg[1] having a range of homogeneity of $ZrH_{1.4}$ to $ZrH_{1.56}$. Compositions between $ZrH_{0.05}$ and $ZrH_{1.4}$ represent a two-phase region. No evidence was found for the hexagonal γ-phase of Hägg. However, a minor transitional phase was identified from crystal structure studies by Jack[2] having the face-centered tetragonal structure.

[1]G. HÄGG, *Z. physik. Chem.*, **11**, 439 (1930).
[2]K. JACK, Private communication.

ABSTRACT NUMBER **64**

DIFFUSION OF HYDROGEN IN HIGH PURITY ZIRCONIUM

Earl A. Gulbransen and Kenneth F. Andrew

THE rate of reaction of zirconium with pure hydrogen was studied over the pressure range of 1.1 to 5.0 cm of Hg of H_2, for a temperature range of 150° to 250°C, and over the composition range of pure Zr to $ZrH_{1.80}$. The reaction is shown to be diffusion-controlled above 200°C with diffusion through the ε and δ phases into a heterogenous system being rate-controlling. Diffusion constants of hydrogen in the α and β phases are evaluated from the data.

ABSTRACT NUMBER **65**

ROOM-TEMPERATURE DUCTILE CHROMIUM

H. Johansen and G. Asai

THE historical development of the effort to find room-temperature ductile chromium is reviewed. Preparation and properties of room-temperature ductile chromium are described. Reasons for the ductility, or lack of it, are advanced on the basis of experiments showing the effect of certain impurities, mechanical work, and heat treatment. Present and possible future uses of ductile chromium are discussed.

ABSTRACT NUMBER **66**

A METALLURGICAL EVALUATION OF IODIDE CHROMIUM

D. J. Maykuth, W. D. Klopp, R. I. Jaffee, and H. B. Goodwin

BOTH the physical condition and the purity of chromium are important factors in its ductility. By proper fabrication techniques, chromium sheet having an average ductile-to-brittle bend transition temperature below 0° can be obtained. Small quantities of oxygen, nitrogen, iron, molybdenum, and silicon have no significant effect on the bend ductility of chromium. How-

ever, similar additions of nickel, carbon, or sulfur adversely affect both the hot and cold ductility.

ABSTRACT NUMBER 67

PREPARATION OF HIGH PURITY THORIUM BY THE IODIDE PROCESS

N. D. Veigel, E. M. Sherwood, and I. E. Campbell

PREPARATION of massive thorium of high purity in lots of several hundred grams each by the van Arkel-de Boer (iodide) process is described. Substantial reduction in the nonmetallic content of the deposits over that of the feed material was obtained. Optimum conditions for deposition were determined.

ABSTRACT NUMBER 68

HIGH TEMPERATURE CRYSTAL STRUCTURE OF THORIUM

P. Chiotti

HIGH temperature x-ray diffraction patterns and electrical resistivity measurements show that thorium transforms from base-centered cubic to body-centered cubic on heating to 1400 $\pm$25°C. Transformation temperature is strongly affected by the amount of carbon present in the metal. The lattice constant of body-centered cubic thorium is 4.11 $\pm$0.01 Å at 1450°C. The lattice constant of the base-centered cubic phase extrapolated to 1450°C is 5.18 $\pm$0.005 Å. Apparatus for resistivity measurements at high temperatures and apparatus for high temperature x-ray diffraction studies are described.

ABSTRACT NUMBER 69

VAPOR PRESSURE OF RHENIUM

D. M. Rosenbaum, E. M. Sherwood, J. M. Blocher, Jr., and I. E. Campbell

VAPOR pressure of rhenium was determined by the Langmuir weight-loss method over a temperature range of 2220° to 2725°C. At 2500°C, the vapor pressure of rhenium is approximately one and one-half times that of tantalum.

ABSTRACT NUMBER **70**

SEMICONDUCTOR RESEARCH AND DEVELOPMENT IN GERMANY

Herbert F. Matare

THE modern status of the semiconductor field has been achieved by the combined efforts of workers in solid state physics, including theory and high purity chemical physics, as well as in the testing and application of semiconducting material in electronics. Besides the big German companies, as for instance Siemens, A. E. G., and Telefunken, some smaller companies have built specialized plants for this work. The most outstanding is the Intermetal Corporation which specializes in semiconductor materials other than germanium and silicon. Color slides of the Intermetal installations illustrate the technical advancement in this field.

ABSTRACT NUMBER **71**

ELECTRICAL PROPERTIES OF SOME GROUP III-GROUP V COMPOUNDS

H. J. Hrostowski and M. Tanenbaum

GaSb, GaAs, and InAs have been prepared by methods previously reported.[1,2] Energy gaps of these compounds have been determined from the long wave length limits of absorption in the infrared.[3] In many ways, GaAs and GaSb are very similar to Si and Ge, respectively. InAs like InSb[3] has electron mobilities in excess of 10,000 cm^2/volt sec. Results of recent measurements of Hall effect and conductivity of these compounds will be described.

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[1]M. Tanenbaum, G. L. Pearson, and W. L. Feldmann, *Bull. Amer. Phys. Soc.*, Nov. 1953.

[2]H. B. Briggs, R. F. Cummings, H. J. Hrostowski, and M. Tanenbaum, *ibid.*

[3]M. Tanenbaum and J. P. Maita, *Phys. Rev.*, **91**, 1009 (1953).

ABSTRACT NUMBER 72

BAND SEPARATION OF A NUMBER OF SEMICONDUCTING COMPOUNDS FROM OPTICAL DATA

Richard W. Koch, James F. Miller, and Harvey L. Goering

ENERGY values for the forbidden band of several semiconducting materials have been determined by spectrophotometric means. Among the materials studied are a series of indium antimonides, both pure and doped samples, indium arsenide, indium phosphide, and gallium arsenide. The dependence of values of the energy gap on the number of impurity carriers in *N*- and *P*-type specimens will be discussed.

ABSTRACT NUMBER 73

PREPARATION AND ELECTRICAL PROPERTIES OF LEAD SULFIDE

W. W. Scanlon and R. F. Brebrick

THE Gibbs phase rule applied to the crystal-vapor system of a binary ionic compound predicts that the composition and, hence, the electrical properties of a crystal can be varied by varying the pressure of one of the constituents of its vapor. Experimental details of this process were worked out for PbS crystals. *P*- and *N*-type crystals were made with carrier concentrations of from 10^{16} to 10^{19}/cc. Hall effect, resistivity, mobility, mean free path, activation energy, and other effects were evaluated on these crystals.

ABSTRACT NUMBER 74

SEMICONDUCTING FILMS

II. InSb Films*

I. Dietrich and K. Lark-Horovitz

FILMS of InSb have been prepared in thicknesses of 3000-8000 Å, using either intermetallic compound ingots or a double beam method. The Hall effect and resistivity of these films has been determined between 77°K and room temperature. Most of the films were *N*-type; however, some were *P*-type. Variable activation energies in the impurity range and about 0.35 ev

at high temperature were observed. Hall effect resistivity in the *P*-type films was observed at about 250°K. Mobilities were of the order of 200 cm^2/vsec.

*Supported by U. S. Signal Corps Contract.

ABSTRACT NUMBER 75

PERIODIC RELATIONS IN THE PROPERTIES OF SEMICONDUCTING COMPOUNDS

R. W. Douglas

THE abundance of known and probable semiconducting compounds invites a search for systematic trends in their properties. For the zinc blende structure, the energy gap can be roughly predicted from the difference in electronegativity of component atoms. Other properties, such as mobility, do not appear to be so systematic in their variation and some reasons for this are examined.

ABSTRACT NUMBER 76

GROWTH AND ORIENTATION OF CRYSTALS OF THE DIAMOND AND ZINC BLENDE TYPE

G. Wolff

A STUDY of crystal growth and crystal habit was undertaken on silicon and germanium, and on III-V-compounds. Germanium crystals show (111), (001), (113), and (011) planes. Silicon additionally showed the (013) plane. All III-V-compounds show (111), ($1\bar{1}1$), and (001) faces. Their cleavage plane is (011) which differs from the cleavage plane (111) of diamond type crystals. In InSb, InAs, and GaSb some additional cleavage along (111) can be observed. Results obtained will be discussed.

ABSTRACT NUMBER 77

CRYSTALLIZATION OF SILICON FROM A FLOATING LIQUID ZONE

Paul H. Keck

IT WAS found that a liquid zone of silicon can be stably supported by surface tension be-

tween solid rods of silicon. This fact makes possible the preparation of very pure silicon single crystals from the melt without requiring a crucible. Details of this method, including instrumentation, shape of the floating zone, and stability limitations, will be discussed. A large number of single crystals have been prepared and good zone purification has been observed. Experimental results will be discussed.

ABSTRACT NUMBER 78

HIGH PURITY SILICON*

Felix B. Litton and Holger C. Andersen

PREPARATION of high purity silicon through the thermal decomposition of silicon tetraiodide was investigated in both a static and intermittent flow system.

The metal produced by the standard van Arkel-de Boer technique showed that its purity was a function of impurities in the source material and not entirely satisfactory for electronic usage. When high purity Electro-Metallurgical silicon was used as the source material, drawn single crystals ranged in resistivity from 0.5 to 3 ohm-cm. By double refining in a static iodide system, drawn single crystals ranged in resistivity from 3 to 8 ohm-cm.

Silicon of higher purity was prepared by iodinating Electro-Metallurgical silicon, fractionally distilling the tetraiodide in a packed quartz column, and subsequently decomposing the purified tetraiodide by vaporizing it over a heated tantalum wire under high vacuum in an intermittent flow system. Melted single crystal silicon produced from tetraiodide distilled once through a 3.7 plate column, at 200 mm pressure, had a resistivity of 18 ohm-cm, whereas doubly distilled tetraiodide had resistivity of 30 ohm-cm.

Work on the fractional distillation of silicon tetraiodide and its thermal decomposition is continuing. Equipment is described for producing metal in 50-gram quantities.

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*The work described is part of a research project carried out by Foote Mineral Company on the preparation of high purity silicon under Contract DA36-039-ac-5550 for the Signal Corps Engineering Laboratories, Ft. Monmouth, N. J.

ABSTRACT NUMBER **79**

PREPARATION AND PROPERTIES OF GERMANIUM-SILICON ALLOYS

C. C. Wang and B. H. Alexander

A METHOD has been developed for making perfectly homogeneous germanium - silicon alloys of any concentration. A modification of this method makes it possible to prepare single crystals of the alloys. The energy gaps of the alloys prepared have been calculated from both infrared absorption measurements and resistivity vs. temperature data. The energy gap increases rapidly with very small additions of silicon and approaches the value for pure silicon at about 50 atomic per cent. The mobility as measured on single crystals of low silicon alloys is nearly the same as that of pure germanium. Point contact and junction diodes made from a germanium-silicon alloy containing only low percentages of silicon have high temperature characteristics substantially better than those made from pure germanium.

ABSTRACT NUMBER **80**

SEMICONDUCTING FILMS

I. Germanium Films*

M. Becker and K. Lark-Horovitz

GERMANIUM films prepared by evaporation[1] or by dissociation of Germane[2] are without exception *P*-type, even after careful annealing. By combining mechanical and chemical methods it has been possible to prepare germanium films of several μ thickness which are single crystals and *N*-type, tested by point contact certification and Hall effect. Films of various resistivities have been prepared and experiments with this film will be described.

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*Supported by U. S. Signal Corps Contract.

[1]J. W. Thornhill and K. Lark-Horovitz, *Phys. Rev.*, **82**, 762 (1951).

[2]W. M. Becker and K. Lark-Horovitz, *Electronics Conference*, **8**, 506 (1953).

ABSTRACT NUMBER 81

PREPARATION OF *N-P*-JUNCTIONS IN GERMANIUM BY SURFACE MELTING, AND THEIR ELECTRICAL PROPERTIES

K. Lehovec, A. Webb, and R. Zuleeg

THE authors have prepared *n-p*-junctions in germanium by partially melting a slab of a single crystal, containing *n*-type impurities; then introduction of *p*-type impurities in excess over the *n*-type impurities; and finally solidification of the melt into a single crystal. The original solid-melt interface forms a *n-p*-junction. Techniques for controlling of the position of the solid-melt interface and for location of the *n-p*-junction, and some of the electrical properties of these junctions will be described.

ABSTRACT NUMBER 82

ELECTROLYTIC STREAM ETCHING OF GERMANIUM

Miles V. Sullivan

THE electrolytic etching of germanium in a stream of a very dilute electrolyte has resulted in: (*a*) elimination of hazardous chemical polishes, (*b*) elimination of several processing steps, and (*c*) improved performance. For single crystal *N*- or *P*-type material and grown junction diodes and transistors, a 0.1% solution of sodium or potassium hydroxide is used.

ABSTRACT NUMBER 83

A STUDY OF THE ETCHING RATE OF SINGLE CRYSTAL GERMANIUM

Paul R. Camp*

FOR several years, the treatment of germanium by etching has played an important role in the production of germanium devices and in the preparation of samples for research purposes. In the last two years, such treatment has become an increasingly important tool for investigations of the orientation and quality of germanium sam-

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ples, different treatments revealing different properties of the material. Treatments themselves have not been well understood. In the hope of progressing toward an understanding of these processes, a study has been made of the etching rate of germanium crystals under various conditions. For simplicity, most of the work was confined to etches containing only HF, H_2O_2, and water. Some effects of temperature and composition of the etchant and of resistivity, orientation, and surface condition of the sample will be discussed.

ABSTRACT NUMBER **84**

INVESTIGATIONS OF SURFACE RECOMBINATION VELOCITIES ON GERMANIUM BY THE PHOTO-ELECTROMAGNETIC METHOD

T. M. Buck and W. H. Brattain

THE Photo-Electromagnetic, or "Deathnium Meter," method of Moss, Pincherle, and Woodward has been used to detect changes in surface recombination velocities resulting from various surface treatments on germanium. Measurements may be made rapidly; small changes in specimen thickness caused by a surface treatment may be ignored; the method can be used to investigate surfaces covered by opaque protective coatings.

The change in surface recombination velocities on heating germanium to 100°C for several minutes has been investigated, using this technique as well as others. The brief heating evidently causes an increase in recombination velocity, as measured at room temperature, from which the specimen recovers slowly over a period of several hours or days.

ABSTRACT NUMBER **85**

ON THE BEHAVIOR OF RAPIDLY DIFFUSING ACCEPTORS IN GERMANIUM

F. van der Maesen and J. A. Brenkman

THE acceptor activity of Cu and Ni and their diffusion in germanium have been investigated. Their acting as acceptors as well as recombination centers gives reason to believe that impurity atoms are placed substitutionally in the lattice. However, the value of 10^{-6} cm²/sec of the diffusion constant makes it likely that the diffusion goes interstitially. This leads to the

concept of an equilibrium existing between substitutional and interstitial atoms. The fact that the diffusivity is dependent on the range of diffusion can be explained qualitatively on the basis of the picture given above.

ABSTRACT NUMBER 86

ULTRASONIC ATTENUATION MEASUREMENTS IN GERMANIUM AND SILICON SINGLE CRYSTALS

A. Granato and Rohn Truell

RESULTS of the measurement of ultrasonic attenuation as a function of frequency will be presented for semiconductors such as germanium and silicon in various states of preparation. The frequency range is 10 to 200 megacycles/sec. The relaxation and dislocation behavior has been and is being studied in considerable detail in this frequency range. Analytical and experimental results of this work are to be presented. Other applications of ultrasonic attenuation measurements to the physics of solids will be mentioned.

ABSTRACT NUMBER 87

ELECTRICAL PROPERTIES OF MICROSCOPIC CRYSTALS OF BORON AND GERMANIUM*

Wm. C. Shaw

METHODS for mounting microscopic crystals, circuitry, and techniques for measuring their electrical properties were developed. Data on voltage-current characteristics, resistivity, Hall and thermoelectric effects in very small ($\sim$ 0.1 mm) single crystals of boron as functions of temperature were compared with data on micro- and macroscopic crystals of germanium.

*This work was performed under the auspices of the Institute for Atomic Research, Ames, Iowa.

ABSTRACT NUMBER 88

"STABILIZED BREAKDOWN" PHENOMENON IN SELENIUM RECTIFIERS

A. C. English, P. J. Colleran, A. Just,
and W. H. Tobin

UNDER certain conditions of temperature and electrical loading it is possible to observe a condition of "stabilized breakdown" in selenium rectifiers where, after passing through a phase of instability and rapid deterioration, a stabilizing mechanism appears which makes the cell quite insensitive to increasing power input or rising ambient temperature. This phenomenon will be discussed and an interpretation suggested on the basis of a localized melting such as might occur at grain boundaries. A remarkably rapid grain growth is observed.

ABSTRACT NUMBER **89**

THE EVALUATION OF NEW SEMICONDUCTORS FOR TRANSISTORS AND APPLICATION TO GALLIUM ANTIMONIDE

D. A. Jenny

IT IS important to learn as much as possible about the properties of a new semiconductor before the time-consuming and often very difficult task of single crystal growing and purification is undertaken. Methods to determine important properties, such as forbidden band width, mobilities, and others, are discussed as to their validity in polycrystalline and relatively impure test samples in comparison with the results from highly purified single crystal material. The application of these methods is demonstrated with gallium antimonide as an example.

ABSTRACT NUMBER **90**

THE PHOTOCONDUCTION OF ZINC OXIDE: A STUDY OF CHEMISORPTION

P. H. Miller, Jr., and D. A. Melnick

ABSORBED oxygen forms an acceptor type surface impurity which removes electrons from interstitial zinc donors. The oxygen can be desorbed by light of forbidden gap energy, presumably because holes are attracted to the charged chemically adsorbed oxygen, converting them to weakly bound physically adsorbed. The rate of readsorption of oxygen is given by the equation,

$dq/dt = a \exp(-bq)$, where q is the adsorbate density. A physical model is proposed to explain this equation.

ABSTRACT NUMBER **91**

TITANIUM DIOXIDE RECTIFIERS: PRODUCTION METHODS AND ELECTRICAL PROPERTIES*

T. S. Shilliday and C. S. Peet

A STUDY was made of several methods for enhancing rectifying characteristics of semiconducing titanium dioxide formed by thermal oxidation of titanium metal. Methods investigated include thermal diffusion of impurities into TiO_2 films, use of a special preoxidation cleaning step for titanium, and formation of artificial barrier layers on TiO_2 films, and anodization of TiO_2 films. The effectiveness of these methods was evaluated on the basis of resultant changes in rectifier characteristics and on the reproducibility of those characteristics.

*Work supported by Wright Air Development Center.

ABSTRACT NUMBER **92**

GERMANIUM AREA PHOTOVOLTAIC CELLS*

Edward Simon

AREA photovoltaic cells have been developed utilizing the barrier produced by thin metallic films on etched germanium surfaces. Active areas up to 1 cm^2 have been produced with surface uniformity of response better than $\pm$ 1 db for a light spot of 0.1 mm diameter. The signal-to-noise ratio compares favorably with other germanium photocells even though its response time is on the order of 10^{-7} sec.

*Supported by U. S. Signal Corps Contract.

ABSTRACT NUMBER **93**

STABILIZATION AND MATCHING OF GERMANIUM DIODES FOR MILITARY APPLICATIONS

W. F. Haldeman

A METHOD is proposed for the stabilization of resistance-current characteristics of germanium diodes by temperature cycling them between two extreme temperatures outside the range of application. A study is made of the effect of repeated temperature cycles. A method of matching the characteristics is set forth. This system, consisting of measuring the forward resistance at particular currents and temperatures, yields information which is punched into IBM cards. These cards are arranged by machine so as to yield matched diodes.

INDUSTRIAL ELECTROLYTIC

ABSTRACT NUMBER **94**

EXPLOSIVE LIMITS OF HYDROGEN-CHLORINE MIXTURES

A. W. Umland

THE lower explosive limit concentration of hydrogen (with upward flame propagation) in mixtures of chlorine containing oxygen, nitrogen, and carbon dioxide in proportions typical to electrolytic chlorine were determined at pressures from 0 to 135 psig. The explosive limit was found to be quite sensitive to variations of pressure and composition. It varied from about 3.1 to about 8.1% hydrogen depending upon the pressure and chlorine concentration.

ABSTRACT NUMBER **95**

DIAPHRAGM TYPE AMALGAM CAUSTIC-CHLORINE CELL

Charles Potter and A. L. Bisio

AN amalgam-type caustic cell was studied. It consisted of an anode compartment which contained brine and graphite anodes, and a cathode compartment which contained a mercury cathode, denuder water, and graphite chips. The compartments were separated by a horizontal "Vincel" cloth diaphragm. The optimum operating characteristics of the experimental cell were denuder liquor velocity, 8.0 gal/hr/ft² Hg; brine liquor velocity, 1.0 gal/hr/ft² Hg; brine temperature, 50°C; current density, 1.0 amp/in.² Hg; and a voltage drop of 3.70 volts. The cell produced 0.80 lb caustic soda per kwhr at a current efficiency of 90-91%. This indicates slightly im-

proved efficiencies over reported present day commercial operation.

ABSTRACT NUMBER 96

THE *p*H IN CHLORINE-CAUSTIC ELECTROLYSIS BY THE MERCURY CELL PROCESS

Lars Barr

THE anolyte composition in mercury cells for chlorine-caustic electrolysis is calculated as a function of *p*H, and the relation between anodic current loss and the anolyte *p*H is derived. Reactions between anodic and cathodic by-products and the dependence of the cathodic current loss upon the anolyte *p*H are also discussed. Finally, certain components of the feed brine which affect the *p*H of the anolyte are examined. It is demonstrated that optimum current efficiency with respect to both chlorine and caustic cannot be reached if the *p*H of the anolyte is greater than 3, that stirring the cathode film, e.g., by solid particles on the mercury surface, decreases the current efficiency, and that the alkalinity of the feed brine, which must not exceed a certain value, is made up of the following concentrations:

$$[OH^-] + 2\,[CO_3^{2-}] + [HCO_3^-] + [ClO^-].$$

ABSTRACT NUMBER 97

THE EFFECT OF IMPURITIES IN THE ELECTROLYSIS OF SODIUM CHLORIDE SOLUTION BY MERCURY PROCESS

Shinzo Okada and Shiro Yoshizawa

THIS investigation deals with the effects of impurities in the electrolysis of sodium chloride solution by mercury process, especially a particular action of magnesium ions, and experimentally points out such an action and its mechanism in the following aspects: (*a*) relations between the current and potential, (*b*) the eddy flow on the electrode surface, (*c*) surface tension on the electrode, and (*d*) potential distribution. It was noticed that the action of magnesium ions has a connection with the polarographic maximum in the relations between the current and potential, and, also, reference was made to the cause of the appearance of the maximum phenomenon.

ABSTRACT NUMBER **98**

SEVERAL PROBLEMS CONCERNING THE CURRENT DISTRIBUTION IN THE INDUSTRIAL ELECTROLYZER

Shinzo Okada, Shiro Yoshizawa, and Fumio Hine

THE state of the electrical field in an electrolyzer cannot be explained completely by the electrostatic or electromagnetic theory, because in this field the chemical polarization always appears near the electrode surface. But we will neglect the effects of this polarization and present the two-dimensional analyses on the forms of the electrolytic cell or field. At first, the problems concerning a Krebs amalgam type chlorine cell and the many grooved graphite anode of a horizontal amalgam type chlorine cell are analyzed. Other results on a rectangular cell with parallel flat plate electrodes are explained.

ABSTRACT NUMBER **99**

CONTINUOUS AND UNIFORM GENERATION OF STIBINE; AN ELECTROLYTIC APPARATUS AND METHOD

Arnold Reisman, Melvin Berkenblit, E. C. Haas, and Allison Gaines, Jr.

A METHOD has been developed for the continuous and uniform generation of stibine-hydrogen atmospheres in the ratio of 1 part stibine to 60 parts hydrogen (0.05% stibine and 3.0% hydrogen in air). Analytical methods for the evaluation of both components have been adapated from existing techniques and verified.

ABSTRACT NUMBER **100**

AN ELECTROLYTIC CELL FOR REGENERATION OF CHROMIC ACID

J. D. Fitzpatrick and R. P. Rolfes

SPENT chrome solution obtained from the oxidation of unsaturated fatty acids is commercially regenerated in continuous electrolytic cells. These cells are operated at 300 amp, 4.2 volts, and a current efficiency of 70% is obtained. The cells are externally cooled to maintain an optimum temperature of 55°C. Feed to

the cells is controlled by a method which eliminates the need for orifices or valves.

ABSTRACT NUMBER 101

FUSED SALT ELECTROLYSIS

Seymour Senderoff

A BRIEF history of the subject of "Fused Salt Electrolysis" will be presented with passing reference to those instances in which commercial application has already been attained. Most interest, at present, seems to be concentrated in the field of refractory metals, such as titanium, molybdenum, zirconium, and others. Demand for these metals in a highly pure state is increasing rapidly, and fused salt electrolysis as a method for their production is under study in a number of laboratories. Recent work in this field will be reviewed. Lastly, the theoretical work which ought to be done for better understanding of fused salt electrolytes and the electrochemical reactions which occur in them will be surveyed.

ABSTRACT NUMBER 102

CATHODE PROCESSES IN ALUMINUM REDUCTION

Morris Feinleib

A BRIEF review of various theories of aluminum production is given. A number of cathodic reactions can occur under the conditions of industrial electrolysis of cryolite-alumina melts, i.e., formation of aluminum or sodium metal, of monovalent aluminum compounds, and of carbides. Experimental studies of these reactions are presented. There appears to be evidence that most, if not all, of the above reactions can proceed simultaneously in an aluminum cell.

ABSTRACT NUMBER 103

ELECTRICAL CONDUCTIVITY AND DENSITY OF MOLTEN CRYOLITE WITH ADDITIVES

Junius D. Edwards, Cyril S. Taylor, Lee A. Cosgrove, and Allen S. Russell

ELECTRICAL conductivities and densities for molten cryolite containing sodium fluoride,

calcium fluoride, aluminum fluoride, and alumina are measured. Molar conductance decreases linearly with mole per cent of the additives. The activation energies for conductance of the mixtures calculated from plots of the Arrhenius equation agree reasonably with the value of 4.48 kcal/mole for pure cryolite. Densities in these systems change linearly with temperature. The complex $NaF \cdot Na_3AlF_6$ is indicated by a density maximum.

ABSTRACT NUMBER **104**

BATHS OF LOW ALUMINA CONCENTRATION IN THE ELECTROLYSIS OF ALUMINUM

Y. Doucet, L. Ferrand, and F. V. Andreae

IN HIS thesis, Rolin has established that alumina dissolved in molten cryolite is dissociated and that this dissociation takes place in two steps. Doucet has calculated the constants K_1 and K_2 of the two steps. Taking advantage of the increased dissociation at low concentrations, Ferrand recommends operation of aluminum cells at low concentrations and low temperatures. His cell incorporates continuous feeding of the alumina, oscillating electrodes, and automatic control of temperature, voltage, and current. The advantages of his process are reduced manpower, low power consumption, and greatly reduced frequency of the anodic effect.

ABSTRACT NUMBER **105**

THE EXTRACTIVE METALLURGY OF ZIRCONIUM BY THE ELECTROLYSIS OF FUSED SALTS

II. Process Development of the Electrolytic Production of Zirconium from K_2ZrF_6

M. A. Steinberg, M. E. Sibert, and E. Wainer

A COMPREHENSIVE investigation is reported dealing with the electrolytic production of zirconium from fused salts. Optimum conditions have been determined for electrolysis of molten K_2ZrF_6-NaCl. Cell designs and operating conditions are described requisite to the preparation of high purity zirconium powder. Electrolytic zirconium is ductile on consolidation and readily fabricated, being comparable to commercial

sponge. Using stable, readily prepared materials and a straightforward fused salt electrolysis, it is felt the process will yield lower cost zirconium.

ABSTRACT NUMBER 106

THE EXTRACTIVE METALLURGY OF ZIRCONIUM BY THE ELECTROLYSIS OF FUSED SALTS

III. Large Scale and Pilot Plant Production

B. C. Raynes, E. Thellmann, M. A. Steinberg, and E. Wainer

THE expansion from the laboratory scale to a larger scale operation for the electrolysis of K_2ZrF_6 in molten NaCl is described. An electrolytic cell capable of producing 30 lb per run of zirconium metal powder of commercial purity and of acceptable fabricating properties is shown and its operation described. This large electrolytic unit produces metal at a rate approaching commercial zirconium sponge producing reactors.

ABSTRACT NUMBER 107

THE ELECTROLYTIC PREPARATION OF MOLYBDENUM FROM FUSED SALTS

II. Preparation of Reduced Molybdenum Halides

Seymour Senderoff and Abner Brenner

AN improved method for the preparation of potassium hexachloromolybdate (III), K_3MoCl_6, is described. Potassium molybdate is dissolved in hydrochloric acid and the solution electrolyzed in a divided cell. Hydrogen chloride gas is then added to the catholyte to precipitate K_3MoCl_6. A new method for preparing molybdenum dichloride, $(MoCl_2)x$, is described. Molydenum pentachloride is reduced with molybdenum powder to the trichloride. This is then heated to produce the molybdenum dichloride by thermal dissociation.

ABSTRACT NUMBER **108**

THE ELECTROLYTIC PREPARATION OF MOLYBDENUM FROM FUSED SALTS

III. Studies of Electrode Potentials

Seymour Senderoff and Abner Brenner

POLARIZATION and equilibrium potential studies in molten halide solutions are described. A new reference half-cell, i.e., Ag, AgCl, was used. It was found that molybdenum is rather noble (between copper and silver) in the emf series in this system but that oxides are preferentially deposited if oxycompounds are present. Evidence for ionic association and complex formation in molten halides at 600°C is discussed.

ABSTRACT NUMBER **109**

THE ELECTROLYTIC PREPARATION OF MOLYBDENUM FROM FUSED SALTS

IV. Preparation of Reduced Molybdenum Halides from Molybdenite Concentrate

Seymour Senderoff and Roger J. Labrie

COMMERCIAL molybdenite concentrates are chlorinated to produce molybdenum pentachloride and sulfur chlorides. Sulfur chlorides are removed and the molybdenum pentachloride is reduced either electrolytically in aqueous solution or by reaction with a hydrocarbon in a nonaqueous system. The aqueous reduction product is recovered as potassium hexachloromolybdate (III), K_3MoCl_6, and the hydrocarbon reduction product is recovered, after heating, as molybdenum trichloride. Either of these salts may be dissolved in alkali halides and electrolyzed to deposit molybdenum metal at the cathode.

ABSTRACT NUMBER **110**

DEVELOPMENT OF A PROCESS FOR THE ELECTROREFINING OF TITANIUM

R. S. Dean and W. W. Gullett

THIS paper will describe the practical aspects of a process for the electrorefining of titanium based on the proposals of Raney. Factors which control the character and place of deposition of

the titanium, as well as the character and means of separation of the anode residue, will be discussed. Alternative procedures for recovering the titanium from the fused electrolyte will also be described. The commercial feasibility of the process for refining scrap, as well as producing virgin titanium, will be indicated.

ABSTRACT NUMBER 111

ELECTRODE REACTIONS IN THE REFINING OF TITANIUM-OXYGEN ALLOYS IN FUSED CHLORIDE BATHS

R. S. Dean, W. W. Gullett, and Leo Goldenberg

THE mechanism of the anode reaction in various chloride electrolytes will be interpreted on the basis of electrochemical measurements. The nature of the cathode product and the reactions by which metallic titanium is produced will be analyzed.

ABSTRACT NUMBER 112

PREPARATION OF TITANIUM BY ELECTROLYTIC REDUCTION OF THE REDUCED OXIDES

M. E. Sibert, Q. H. McKenna, M. A. Steinberg, and E. Wainer

TITANIUM metal of 99% purity has been prepared by electrolysis of reduced oxides in melts of alkaline earth halides. Several methods were concurrently developed to produce the reduced oxides. Design and operation of the electrolytic cell are discussed; metal is produced as crystalline powder held in a salt matrix, and is recovered by aqueous techniques. Although the metal is not generally as pure as commercial titanium, a number of potential applications are possible.

ABSTRACT NUMBER 113

PREPARATION OF TITANIUM BY FLUORIDE ELECTROLYSIS

M. A. Steinberg, S. Carlton, M. E. Sibert, and E. Wainer

PREPARATION of commercially pure titanium metal powder by electrolysis of K_2TiF_6 in

molten NaCl is described. The process is carried out under an inert atmosphere in an all-graphite cell. Conditions of the electrolysis and properties of titanium metal so produced are discussed. The process is capable of producing metal of acceptable purity which may be fabricated by standard methods. Material may be produced either as crystalline metal or as coarse thin metal flakes.

ABSTRACT NUMBER **114**

ANODIC BEHAVIOR OF TITANIUM IN FUSED SALT BATHS

M. E. Straumanis and A. W. Schlechten

AN ATTEMPT is made to explain the impossibility of cathodic deposition of titanium in the presence of air by studying the behavior of the cell Ti-fused NaCl or KCl-Pt. Experiments show that this cell develops quite a high current in the presence of air (oxygen); on open circuit the cell develops an emf as high as 1.5 volts at a temperature of 850°C. The direction of the current indicates that titanium goes into solution; at the Pt cathode, products are formed which give a basic reaction if dissolved in water. Studies with a more improved cell confirm that the titanium metal acts as an anode going into solution in the form of Ti ions, while, on the cathode, Na or K ions are discharged; these immediately react with the oxygen of the air to form the respective oxides. Only a very weak current could be obtained if the cell was placed in vacuum or in an inert gas. The conclusion is that in the case of the reverse process, during electrolysis of an alkali salt containing some titanium salt, no titanium ions will be discharged on the cathode in the presence of air, but only the formation of alkali metal oxides will result.

ABSTRACT NUMBER **115**

PYROSOL FORMATION AND CORROSION OF TITANIUM IN FUSED SALTS

C. B. Gill, M. E. Straumanis, and A. W. Schlechten

AMONG the various factors affecting the deposition of titanium from a molten salt, it seemed desirable to determine the extent of corrosion of the metal in the various molten salts. Experiments carried out in air showed that titanium is strongly attacked by fused salts, such as NaCl, KCl, the mixture of NaCl and KCl, LiCl,

$CaCl_2$, and by a series of other fused salts and mixtures. The greatest loss of weight of Ti resulted from the mixture of 50% NaCl and 50% NaF at 850°C in which case the titanium was completely dissolved in a few hours. The next greatest attack occurred in KCl. Salt fumes also attacked titanium severely.

Analysis of the dark corrosion products accumulated in the salt baths showed that the deposit consisted mainly of metallic titanium in the form of a fine powder. Thus the compact metal was dispersed in the liquid salt (800°C and up) in the form of a metallic fog, or "pyrosol." However, the dispersion of the metal in the fused salt in vacuum was only very slight. The same behavior was shown also by zirconium and hafnium.

ABSTRACT NUMBER 116

DEPOSITION OF TITANIUM COATINGS FROM PYROSOLS

A. W. Schlechten, M. E. Straumanis, and C. B. Gill

IT HAS been found that the titanium dispersed in fused salts can be deposited upon other metals, especially on copper and iron. For example, if a piece of copper sheet is placed in close proximity to a titanium sheet (but not in actual contact) and then the whole is immersed into a fused salt, preferably NaCl or KCl, titanium will be transferred to the copper sheet. The thickness of the titanium layer on the copper increased with temperature and with time, approaching a maximum thickness of 0.001 to 0.007 in. Titanium forms a coherent layer on the metals mentioned and protects them from corrosion. The substrate can be dissolved from the reverse side (Fe in $FeCl_3$, Cu in HNO_3), and the titanium coating remains.

The mechanism of titanium transfer is thought to consist of titanium pyrosol formation and the deposition of the titanium particles upon other metals with the formation of alloys. A similar behavior has been observed with other metals.

THEORETICAL ELECTROCHEMISTRY

ABSTRACT NUMBER **117**

RADIO TRACER STUDIES OF ELECTROLYTIC ACTION ON METAL SURFACES

Massoud T. Simnad

(NO ABSTRACT AVAILABLE)

ABSTRACT NUMBER **118**

APPLICATIONS OF ULTRASONIC WAVES IN THEORETICAL ELECTROCHEMISTRY

Ernest Yeager

(NO ABSTRACT AVAILABLE)

ABSTRACT NUMBER **119**

USE OF ISOTOPES IN THE STUDY OF IONIC HYDRATION

Henry Taube

(NO ABSTRACT AVAILABLE)

ABSTRACT NUMBER **120**

ALTERNATING CURRENT ELECTROLYSIS

A. E. Remick

(NO ABSTRACT AVAILABLE)

ABSTRACT NUMBER **121**

NUCLEAR MAGNETIC RESONANCE AS APPLIED TO ELECTROLYTIC SOLUTIONS

H. S. Gutowsky

(NO ABSTRACT AVAILABLE)

ABSTRACT NUMBER **122**

TECHNIQUES FOR THE STUDY OF HYDROGEN ELECTRODE KINETICS

J. O'M. Bockris

(NO ABSTRACT AVAILABLE)

ABSTRACT NUMBER **123**

INVESTIGATIONS OF EQUILIBRIA IN CONCENTRATED SOLUTIONS BY MEANS OF RAMAN SPECTRA

T. F. Young

(NO ABSTRACT AVAILABLE)

ABSTRACT NUMBER **124**

CURRENT INTERRUPTER TECHNIQUES IN THE STUDY OF ELECTRODE PROCESSES

Sigmund Schuldiner

(NO ABSTRACT AVAILABLE)

ABSTRACT NUMBER **125**

APPLICATION OF VOLTAMMETRY AT CONSTANT CURRENT TO ELECTROCHEMICAL STUDIES

Paul Delahay

(NO ABSTRACT AVAILABLE)

ABSTRACT NUMBER **126**

DISSOCIATION OF ACIDS IN AQUEOUS SOLUTION

T. G. Owe Berg

EXPERIMENTAL results on rates of dissolution and potentials of metals in acid solutions have been related to the degree of dissociation as determined from Raman intensities. It has been shown that the degree of dissociation

is related to the structure of the liquid and that it is independent of temperature. Consequences are drawn from those results as to the mechanism of dissociation. Those are discussed in relation to Brönsted's definition of dissociation. It is shown that Brönsted's definition includes unnecessarily severe restrictions which are due to its not taking the liquid structure into account.

ABSTRACT NUMBER 127

HEATS OF FORMATION AND ENTROPIES OF HS^- AND $S^=$. POTENTIAL OF SULFIDE-SULFUR COUPLE

J. W. Kury, A. J. Zielen, and W. M. Latimer

THE heat of neutralization of H_2S solutions by NaOH was measured at 25° for various mole ratios of NaOH to H_2S. These data, with the two dissociation constants of H_2S, allow calculations of the free energies and heats of formation and partial molal entropies of $S^=$ and HS^-. Results are for $S^=$ and HS^-, respectively: $\Delta F^\circ = 20.6$ and 3.00 kcal, $\Delta H^\circ = 7.8$ and -4.10 kcal, and $\bar{S}^\circ = -4$ and 15.0 eu. The potential of the $S^=-S$ couple is 0.447 volt.

ABSTRACT NUMBER 128

ELECTROLYTIC OXIDATION OF ZINC IN ALKALINE SOLUTIONS

Thedford P. Dirkse

THE electrolytic oxidation of zinc in alkaline solutions was studied by measuring electrode potentials of zinc in such solutions under equilibrium conditions. Results indicate that in this oxidation a form of zincate ion is produced.

ABSTRACT NUMBER 129

EVOLUTION OF STIBINE AT ANTIMONY CATHODES

H. W. Salzberg* and A. J. Andreatch

FORMATION of stibine at antimony cathodes was studied by absorbing the cathode gas and analyzing the solution for antimony. Results indicated that the stibine was formed by the elec-

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trochemical discharge of a water molecule upon an antimony atom which was in contact with either two adsorbed hydrogen atoms or an adsorbed hydrogen molecule. Rate of the reaction was found to depend upon the voltage difference between the electrode and the solution. The stibine formed was found to be inert to acid, but was readily decomposed by alkali. Decreased rates of stibine formation in highly acid solution are thought to mean that high voltages, and, therefore, high overvoltages are not associated with hydronium ion discharge, but with water discharge.

ABSTRACT NUMBER 130

WATER ADSORPTION AND HYDROGEN EVOLUTION

H. W. Salzberg*

PREVIOUS work indicates that water molecules are discharged at lead, platinum, and antimony cathodes in acid solutions at current densities above 10-100 ma/cm². An attempt is made to explain this on the basis of formation of an electrostatically attracted sheath of water dipoles through which hydronium ions do not penetrate and which consequently causes depletion of hydronium ions at the surface of a working electrode. An equation is derived relating the surface concentration of hydronium ions to the current, voltage, temperature, heat of adsorption of water, and acidity of the solution. Calculations are made on the basis of this equation to indicate at what current density such a sheath would form with resultant hydronium ion depletion and water discharge.

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ABSTRACT NUMBER 131

DETERMINATION OF BARRIER LAYER THICKNESS OF ANODIC OXIDE COATINGS

M. S. Hunter and P. Fowle

A NOVEL method is described for measuring the thickness of a barrier type anodic oxide coating or the barrier layer portion of a porous type anodic oxide coating. This method is used to follow the evolution of the barrier layer during early stages of formation of a porous type

coating on aluminum and to establish certain dimensions of fundamental oxide cells which comprise this type of coating.

ABSTRACT NUMBER 132

FACTORS AFFECTING THE FORMATION OF ANODIC OXIDE COATINGS

M. S. Hunter and P. Fowle

THE effect of variations in electrolyte and forming conditions on the formation of porous type anodic oxide coatings on aluminum are discussed, with particular reference to the manner in which these variables control oxide formation, pore development, and the thickness of the barrier layer. Formation and solution rate data are applied to show that, during the formation of a porous type coating, conditions at pore bases are vastly different from those existing in the main body of the electrolyte.

ABSTRACT NUMBER 133

MEASUREMENT OF ELECTROLYTIC CONDUCTIVITY BY BALLISTIC GALVANOMETER AND CONDENSER: APPLIED TO ANILINE

G. W. Thiessen and Students

THE conductivity of pure aniline has been shown to be lower than any values previously recorded. This work, done by means of the ballistic galvanometer and calibrated condenser, demonstrated that the conductivity of pure aniline is increased by standing and by the addition of amides.

ABSTRACT NUMBER 134

HYDROGEN OVERVOLTAGE ON BRIGHT PLATINUM

II. *p*H and Salt Effects in Acid, Neutral, and Alkaline Solutions

Sigmund Schuldiner

HYDROGEN overvoltage on bright platinum was measured over the *p*H range 0.5-12.1. Effects of added sodium and ammonium ions and

*p*H effects were determined. Relative rates of the over-all hydrogen producing reactions at low current densities were determined for the solutions studied. Mechanisms of hydrogen overvoltage in these solutions are discussed.

ABSTRACT NUMBER 135

EFFECT OF SOLVENTS AND ELECTROLYTES ON POLAROGRAMS OF CARBON TETRACHLORIDE

Johan J. Lothe* and L. B. Rogers

POLAROGRAPHIC reduction of carbon tetrachloride has been studied in different mixtures of organic solvents with water, using a number of alkali halides and tetraalkylammonium halides as supporting electrolytes. On the positive side of the electrocapillary maximum of mercury, a marked effect of the nature of the anion of the supporting electrolyte on the half-wave potential was observed. On the negative side of the electrocapillary maximum, the cation effected a similar change. It was further observed that the reduction became more difficult with increasing concentration of organic solvent. This last effect can be interpreted in terms of a change in the activation energy of the electron transfer process. An equation giving the effect of drop-time on the observed half-wave potential for irreversible reactions, where the rate of the electron transfer process is the limiting factor, has been derived. This equation has been verified experimentally with carbon tetrachloride. Finally, factors governing the occurrence of maxima on the polarographic wave in predominantly aqueous solutions have been investigated.

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ABSTRACT NUMBER 136

IONIC MASS TRANSFER AND CONCENTRATION POLARIZATION AT ROTATING ELECTRODES

M. Eisenberg,* C. W. Tobias, and C. R. Wilke

RATES of ionic mass transfer at nickel electrodes rotating about their axes in the cen-

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ter of stationary electrodes were studied using the ferri-ferrocyanide couple in alkaline solutions. A general mass transfer correlation was found to apply equally well to dissolution rates of rotating solids and to rates of ionic mass transfer at rotating electrodes. This correlation takes into account physical properties of the system as well as geometric and hydrodynamic factors. The correlation enables the prediction of limiting currents and concentration polarization at rotating electrodes under a wide range of conditions.

ABSTRACT NUMBER **137**

ELECTROCHEMICAL POLARIZATION OF ZIRCONIUM IN DISTILLED WATER

Norman Hackerman and Otto L. Willbanks, Jr.

CATHODIC and anodic polarization curves for zirconium in air-saturated distilled water at 40°C were determined in the ranges 3×10^{-7} to 1.0×10^{-3} and 1.0×10^{-5} to 3.0×10^{-3} amp/cm², respectively. Evidence of formation of a hydride at a constant potential of —0.3 volt (saturated calomel scale) was obtained. In the region of hydrogen evolution, the potential varied linearly with log current density, showing a slope of —0.14. On anodic polarization, a similar plot gave a slope of 0.07. Slight corrosion was noted during anodic polarization, and it was visibly worse in experiments run at about 90°C.

ABSTRACT NUMBER **138**

MECHANISM OF THE COPPER-ARSENIC METHOD OF PURIFYING ZINC SULFATE ELECTROLYTE

G. R. Van Houten* and L. E. Stout

TRACE and near trace quantities of cobalt, germanium, and other elements are removed from solution by the formation of intermetallic compounds. Depending on the particular element and concentration, the element is either a primary constituent of the intermetallic or an impurity in the intermetallic lattice, having atomic and ionic dimensions similar to those of one or more of the primary intermetallic constituents, e.g., Ge in Cu_5Ge has the same dimensions as As

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in Cu_3As. Possible extensions of the method to purifications of other electrolytes or recovery of trace elements are numerous.

ABSTRACT NUMBER 139

ELECTRODEPOSITION OF ALKALI METALS FROM NONAQUEOUS SOLUTIONS

Harry C. Mandell, Jr., Wallace M. McNabb, and J. Fred Hazel

ELECTROLYSES of several lithium and potassium salts in pyridine, quinoline, and nitrobenzene have been studied. Decomposition potentials and conductivities of the systems were determined. Lithium was electrodeposited from its iodide dihydrate in all three solvents and from its bromide in pyridine and quinoline. Potassium was plated from its thiocyanate and iodide in pyridine. Deposits were formed on platinum cathodes.

ABSTRACT NUMBER 140

POTENTIOMETRIC TITRATION OF SIMPLE SALTS WITH POTASSIUM IN LIQUID AMMONIA*

George W. Watt, Gregory R. Choppin,† and James L. Hall‡

BY MEANS of potentiometric titration of solutions of salts with solutions of potassium in liquid ammonia at −38°, it has been shown that bismuth(III) iodide as reduced to Bi°, K_3Bi_5, and K_3Bi_3 without intermediation of either the +2 or +1 oxidation state of bismuth. Reduction of iron(II) bromide is very complex and apparently does not involve the intermediate formation of Fe^{+1}. Reduction of potassium nitrate involves only reduction of nitrate ion to nitrite ion, followed by precipitation of potassium hydronitrite. Data relative to reduction of cobalt(II) nitrate have permitted a choice between two possible reduction mechanisms previously proposed. Data presented in this paper clearly demonstrate the

*This work was supported in part by the Office of Naval Research, Contract N6onr-26610.

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usefulness of the potentiometric titration technique in study of the mechanism of inorganic reduction reactions in ammonia.

ABSTRACT NUMBER **141**

POTENTIOMETRIC TITRATION OF AMMINES OF RHODIUM, IRIDIUM, AND PLATINUM WITH SOLUTIONS OF POTASSIUM AND POTASSIUM AMIDE IN LIQUID AMMONIA*

George W. Watt, Gregory R. Choppin,† and James L. Hall‡

POTENTIOMETRIC titration of tetrammineplatinum(II) bromide with potassium in liquid ammonia at −38° shows that reduction of this salt to an ammine of platinum(0) is exactly a two-electron change and that the +1 oxidation state of platinum is not an intermediate. Similar reduction of bromopentammineiridium (III) bromide is apparently more complex and leads to observed changes in potential that do not correspond to any reasonable or probable reactions. Titration of this same iridium salt with potassium amide solution, however, provides evidence for stepwise replacement of bromine by amido groups followed by conversion of the resultant iridium(III) amide to (probably) a potassium amidoiridate(III). Bromopentamminerhodium(III) bromide and potassium amide react similarly, but only to and including the formation of rhodium(III) amide.

*This work was supported in part by the Office of Naval Research, Contract N6onr-26610.

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ABSTRACT NUMBER **142**

HYDROGEN OVERVOLTAGE MEASUREMENTS ON PLATINUM AND PLATINUM ALLOYS*

Gerald Lozier, Ernest Yeager, and Frank Hovorka

THE commutator technique has been used to measure hydrogen overvoltage on bright platinum and alloys of platinum with iridium, gold, and silver. The Tafel slope for platinum shifts

*Research supported by the Office of Naval Research.

from 0.025 to 0.1 at current densities of 0.1 to 1 amp/cm^2. Differences in the slope and intercept constants of the Tafel equation have been determined in the case of the alloys. Effects of ultrasonically induced cavitation also have been noted with the alloys.

ABSTRACT NUMBER 143

EFFECT OF ULTRASONICS ON ELECTRODE PROCESSES

A. L. Ferguson, L. O. Case, F. A. Reiss, and S. H. Dreisbach

DEPOLARIZING effects of magnetostrictive vibrations have been studied with metallic electrodes mounted directly on the end of a vibrating nickel tube. Among the systems investigated were: platinum and silver in sulfuric acid with atmospheres of hydrogen and of nitrogen; copper and lead in complex baths. The effects are highly specific for individual systems studied and in some cases are of such magnitude as to suggest effects on the metal as well as on the solution side of the interface.

ABSTRACT NUMBER 144

EFFECTS OF ULTRASONIC WAVES ON CONCENTRATION GRADIENTS AT ELECTRODES*

Robert Penn, Ernest Yeager, and Frank Hovorka

SCHLIEREN techniques have been used to study the effects of ultrasonic waves on concentration gradients at anodes and cathodes. Moderately intense ultrasonic waves are considerably more effective than ordinary agitation in disrupting these gradients. Polarization measurements confirm this conclusion. With standing waves of low intensities, concentration gradients are localized at displacement nodes or loops depending on whether there is an excess or deficit of electrolyte at the electrode. Ridges separated by a half wave length are produced on the electrode surfaces.

*Research supported by the Office of Naval Research.

ABSTRACT NUMBER **145**

HYDROGEN OVERVOLTAGE IN PHOSPHATE AND AMMONIUM BUFFERS

William Van Dusen, Jr., Alma Elizabeth Chick, and Andre J. deBethune

THE hydrogen discharge reaction has been studied polarographically in buffer solutions covering *p*H range 1 to 8. Dilute acids show normal behavior, with or without salt effect. Dihydrogen phosphate buffers show an enhanced overvoltage with twice the normal slope ($b = 240$ mv). Ammonium buffers show an enhanced overvoltage with the normal slope. The transition between the acid and ammonium mechanism has been observed. Different behaviors are attributed to the sign of the *p*H determining ion.

ABSTRACT NUMBER **146**

SOME PROPERTIES OF TIN-II SULFATE SOLUTIONS AND THEIR ROLE IN ELECTRODEPOSITION OF TIN

III. Solutions with Tin-II Sulfate, Sulfuric Acid, and Addition Agents

C. A. Discher

DENSITY, refractive index, surface tension, viscosity, freezing point, conductivity, transference numbers, and electrode potentials were measured for tin-II sulfate-sulfuric acid solutions containing addition agents. Addition agents were selected to give a range of deposit types. Specific properties for each solution were classified according to the deposit obtained from the solution in order to determine behavior patterns. Molar refraction, surface tension, and equivalent conductivity show well-defined correlation to deposit type. Viscosity and freezing points show some correlation. The other properties show little if any correlation to deposit obtained.

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FALL MEETING

at the

STATLER HOTEL

Boston, Massachusetts

October 3, 4, 5, 6, and 7, 1954

SESSIONS ON

Battery

Corrosion

Electrodeposition

Electrothermics

Abstracts for the Fall Meeting (not exceeding 75 words in length) must reach the Secretary's Office, 216 West 102nd Street, New York 25, N. Y.
not later than July 15, 1954
in order to be included in the program

INDEX TO AUTHORS

	Page
Abraham, A. D.	17, 54
Agnew, John T.	8, 31
Alexander, B. H.	19, 61
Amey, W. G.	11, 39
Andersen, Holger C.	19, 60
Andreae, F. V.	25, 71
Andreatch, A. J.	28, 79
Andrew, Kenneth F.	17, 54, 55
Asai, G.	17, 55
Atkinson, R.	15, 50
Atkinson, Russell H.	17, 54
Barr, Lars	23, 68
Becker, M.	19, 61
Berg, T. G. Owe	28, 78
Berkenblit, Melvin	24, 69
Bisio, A. L.	23, 67
Blocher, J. M., Jr.	17, 56
Block, F. E.	17, 54
Bockris, J. O'M.	27, 78
Bowers, Spotswood D., Jr.	13, 44
Brattain, W. H.	19, 63
Brebrick, R. F.	18, 58
Brenkman, J. A.	19, 63
Brenner, Abner	25, 72, 73
Broecker, Joanne B.	9, 32
Buck, T. M.	19, 63
Burns, Laurence	13, 43
Callinan, Thomas D.	9, 34
Camp, Paul R.	19, 62
Campbell, I. E.	17, 56
Carlson, Carl J.	16, 53
Carlton, S.	26, 74
Case, L. O.	30, 86
Chapman, J. J.	11, 38
Chick, Alma Elizabeth	30, 87
Chiotti, P.	17, 56
Choppin, Gregory R.	30, 84, 85
Clark, W. R.	11, 39
Clayton, J. C.	11, 39
Colleran, P. J.	20, 65
Cosgrove, Lee A.	25, 70
Crutchfield, C. A., Jr.	14, 48
Dean, R. S.	26, 73, 74
deBethune, Andre, J.	30, 87
Deer, Leon L.	8, 31
Delahay, Paul	28, 78
Destriau, G.	13, 45
Dichter, Channing	15, 49
Dietrich, I.	18, 58
Dirkse, Thedford P.	28, 79
Discher, C. A.	30, 87

	Page
Doigan, Paul	11, 37
Doucet, Y.	25, 71
Douglas, R. W.	18, 59
Dreisbach, S. H.	30, 86
Dropkin, J. J.	13, 44, 45
Durra, J.	10, 34
Edwards, Junius D.	25, 70
Eisenberg, M.	29, 82
English, A. C.	20, 65
Evans, L. W.	15, 49
Feinleib, Morris	25, 70
Ferguson, A. L.	30, 86
Ferrand, L.	25, 71
Fitzpatrick, J. D.	24, 69
Fowle, P.	28, 80, 81
Frey, Raymond M.	9, 32
Frisco, L. J.	11, 37
Gaines, Allison, Jr.	24, 69
Gemant, Andrew	9, 32
Gill, C. B.	26, 75, 76
Ginther, Robert J.	14, 46
Glaser, Frank W.	16, 52
Goering, Harvey L.	18, 58
Goldberg, Paul	12, 42
Goldenberg, Leo	26, 74
Goldstein, B.	13, 44
Good, Robert J.	9, 33
Goodwin, H. B.	17, 55
Granato, A.	20, 64
Gulbransen, Earl A.	17, 54, 55
Gullett, W. W.	26, 73, 74
Gutowsky, H. S.	27, 77
Haas, E. C.	24, 69
Hackerman, Norman	29, 83
Haldeman, W. F.	20, 66
Hall, James L.	30, 84, 85
Halpin, A. T.	13, 45
Hardy, Austin E.	12, 40
Hardy, Edgar E.	10, 35
Hazel, J. Fred	11, 14, 29, 39, 47, 48, 84
Hazelwood, R. Nichols	9, 32
Heyman, M. D.	9, 34
Higgins, W. T.	10, 35
Hine, Fumio	23, 69
Hovorka, Frank	30, 85, 86
Hrostowski, H. J.	18, 57
Hunter, M. S.	28, 80, 81
Hunter, Richard S.	12, 40
Hutchison, Clyde A., Jr.	9, 31
Jaffee, R. I.	17, 55

	Page
Jenny, D. A.	20, 65
Johansen, H.	17, 55
Just, A.	20, 65
Keck, Paul H.	19, 59
Kinney, D. E.	14, 46
Kirkpatrick, G. P.	15, 48
Klick, Clifford C.	13, 43
Klopp, W. D.	17, 55
Kluz, Stanley	16, 51
Kobe, Kenneth A.	16, 53
Koch, Richard W.	18, 58
Kotera, Yoshihide	14, 47
Krantz, F. H.	11, 39
Kremheller, Alfred	12, 41
Kury, J. W.	28, 79
Labrie, Roger J.	26, 73
Lambe, John	13, 43
Lark-Horovitz, K.	18, 19, 58, 61
Latimer, W. M.	28, 79
Lehovec, K.	19, 62
Lenel, F. V.	16, 52
Leverenz, Humboldt W.	12, 41
Levine, Albert K.	12, 42
Liebson, S. H.	12, 40, 42
Litton, Felix B.	19, 60
Long, Roger A.	16, 51
Lothe, Johan J.	29, 82
Lotz, Edwin	10, 36
Lozier, Gerald	30, 85
Maisel, Leonard	14, 48
Mallett, M. W.	16, 53
Mandell, Harry C., Jr.	29, 84
Matare, Herbert F.	18, 57
Matossi, Frank	13, 44
Maykuth, D. J.	17, 55
McKenna, Q. H.	26, 74
McLean, D. A.	9, 33
McLean, H. T.	9, 32
McNabb, Wallace M.	11, 14, 29, 39, 48, 84
McQuistan, Richmond B.	8, 31
Melnick, D. A.	20, 65
Miller, James F.	18, 58
Miller, P. H., Jr.	20, 65
Moskowitz, David	16, 52
Nudelman, Sol	13, 44
Okada, Shinzo	23, 68, 69
Palmour, Hayne, III	11, 38
Palumbo, Dominic T.	12, 42
Peet, C. S.	20, 66

	Page
Penn, Robert	30, 86
Post, Benjamin	16, 52
Potter, Charles	23, 67
Raynes, B. C.	25, 72
Read, R.	15, 50
Rector, P.	10, 36
Reisman, Arnold	24, 69
Reiss, F. A.	30, 86
Remick, A. E.	27, 77
Rogers, L. B.	29, 82
Rolfes, R. P.	24, 69
Rosenbaum, D. M.	17, 56
Ruby, J. A.	10, 35
Rulon, Richard M.	13, 45
Russell, Allen S.	25, 70
Rychlewski, T. V.	15, 49
Salzberg, H. W.	28, 79, 80
Saunders, J. H.	10, 35
Scanlon, W. W.	18, 58
Schlechten, A. W.	26, 75, 76
Schnable, G. L.	11, 39
Schuldiner, Sigmund	28, 29, 78, 81
Searcy, A. W.	16, 52
Sekine, Tadao	14, 47
Senderoff, Seymour	24, 25, 70, 72, 73
Shaler, A. J.	15, 50
Shaw, Wm. C.	20, 64
Sherburne, A. J.	11, 38
Sherwood, E. M.	17, 56
Shilliday, T. S.	20, 66
Sibert, M. E.	25, 26, 71, 74
Simnad, Massoud T.	27, 77
Simon, Edward	20, 66
Snyder, Russell B.	14, 48
Spiers, C. F.	11, 37
Srepel, Vanja	15, 49
Staley, R. W.	11, 38
Steinberg, M. A.	25, 26, 71, 72, 74
Stericker, William	14, 47
Stout, L. E.	29, 83
Straumanis, M. E.	26, 75, 76
Sullivan, Miles V.	19, 62
Swindells, Frank E.	14, 47
Tanenbaum, M.	18, 57
Taube, Henry	27, 77
Taylor, Cyril S.	25, 70
Tharp, A. G.	16, 52
Thellmann, E.	25, 72
Thiessen, G. W.	29, 81
Tobias, C. W.	29, 82
Tobin, W. H.	20, 65
Truell, Rohn	20, 64

	Page
Umland, A. W.	23, 67
van der Maesen, F.	19, 63
Van Dusen, William, Jr.	30, 87
Van Houten, G. R.	29, 83
Veigel, N. D.	17, 56
Wainer, E.	25, 26, 71, 72, 74
Wang, C. C.	19, 61
Watson, W. R.	13, 45
Watt, George W.	30, 84, 85
Webb, A.	19, 62
Wehrmann, Ralph	16, 51
Westbrook, J. H.	16, 51
Wikstrand, W. C.	11, 37
Wilke, C. R.	29, 82
Willbanks, Otto L., Jr.	29, 83
Williams, A. J., Jr.	11, 39
Wismer, M.	10, 34
Wolff, G.	18, 59
Wulff, J.	15, 50
Yeager, Ernest	27, 30, 77, 85, 86
Yntema, L. F.	16, 51
Yoshizawa, Shiro	23, 68, 69
Young, T. F.	27, 78
Zielen, A. J.	28, 79
Zuleeg, R.	19, 62

NOTES

NOTES

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